METTLER TOLEDO

Operation Manual Multiparameter Transmitter M400

Transmitter Multiparameter M400
52 121 378

Operation Manual Multiparameter Transmitter M400

Content

1 Introduction

Statement of Intended Use – The M400 multiparameter transmitter is a single- channel online process instrument for measuring various properties of fluids and gases. These include Conductivity, Dissolved Oxygen, Dissolved Carbon Dioxide (CO_2) and pH/ORP. The transmitter handles also ISFET sensors used for pH measurement. The M400 is available in three different levels. The level indicates the amount of measurement parameters which can be covered. The parameters are indicated on the label on the back of the system.

The M400 is a unique mixed mode transmitter who can handle conventional sensors (analog) or ISM sensors (digital).

M400 parameter fit guide

Parameter	**Type 1**		**Type 1 Cond Ind**		**Type 2**		**Type 3**	
	Analog	ISM	Analog	ISM	Analog	ISM	Analog	ISM
pH/ORP	•	•	–	•	•	•	•	•
pH (ISFET)	•	–	–	–	•	–	•	–
Conductivity 2-e	•	–	–	–	•	–	•	–
Conductivity 4-e	•	•	–	•	•	•	•	•
Conductivity inductive	–	–	•	–	–	–	–	–
Dissolved oxygen ppm/ppb	–	–	–	–	•/–	•/–	•/•	•/•
Oxygen in gas ppm / ppb	–	–	–	–	•/–	•/–	•/•	•/•
Oxygen optical ppm/ppb	–	–	–	–	–	•/–	–	•/•
Dissolved Carbon Dioxide	–	–	–	–	–	–	•	–

A large four line backlit Liquid Crystal Display conveys measuring data and setup information. The menu structure allows the operator to modify all operational parameters by using keys on the front panel. A menu-lockout feature, with password protection, is available to prevent the unauthorized use of the meter. The M400 Multiparameter transmitter can be configured to use its four analog and/or six relay outputs for process control.

The M400 Multiparameter transmitter is equipped with a USB communication interface. This interface provides real-time data output and complete instrument configuration capabilities for central monitoring via Personal Computer (PC).

This description corresponds to the firmware release, version 1.4 for the transmitter M400 Type 1, M400 Type 2 and M400 Type 3 as well as to the firmware release, version 1.1 for the transmitter M400 Type 1 Cond Ind. Changes are taking place constantly, without prior notification.

2 Safety instructions

This manual includes safety information with the following designations and formats.

2.1 Definition of equipment and documentation symbols and designations

WARNING: POTENTIAL FOR PERSONAL INJURY.

CAUTION: possible instrument damage or malfunction.

NOTE: Important operating information.

On the transmitter or in this manual text indicates: Caution and/or other possible hazard including risk of electric shock (refer to accompanying documents)

The following is a list of general safety instructions and warnings. Failure to adhere to these instructions can result in damage to the equipment and/or personal injury to the operator.

- The M400 Transmitter should be installed and operated only by personnel familiar with the transmitter and who are qualified for such work.
- The M400 Transmitter must only be operated under the specified operating conditions (see section 16 "Specifications").
- Repair of the M400 Transmitter must be performed by authorized, trained personnel only.
- With the exception of routine maintenance, cleaning procedures or fuse replacement, as described in this manual, the M400 Transmitter must not be tampered with or altered in any manner.
- Mettler-Toledo accepts no responsibility for damage caused by unauthorized modifications to the transmitter.
- Follow all warnings, cautions, and instructions indicated on and supplied with this product.
- Install equipment as specified in this instruction manual. Follow appropriate local and national codes.
- Protective covers must be in place at all times during normal operation.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by it against hazards may be impaired.

WARNINGS:
Installation of cable connections and servicing of this product require access to shock hazard voltage levels.
Main power and relay contacts wired to separate power source must be disconnected before servicing.
Switch or circuit breaker shall be in close proximity to the equipment and within easy reach of the OPERATOR; it shall be marked as the disconnecting device for the equipment.
Main power must employ a switch or circuit breaker as the disconnecting device for the equipment.
Electrical installation must be in accordance with the National Electrical Code and/or any other applicable national or local codes.

NOTE: RELAY CONTROL ACTION
the M400 transmitter relays will always de-energize on loss of power, equivalent to normal state, regardless of relay state setting for powered operation. Configure any control system using these relays with fail-safe logic accordingly.

NOTE: PROCESS UPSETS
Because process and safety conditions may depend on consistent operation of this transmitter, provide appropriate means to maintain operation during sensor cleaning, replacement or sensor or instrument calibration.

NOTE: This is a 4-wire-product with an active 4–20 mA analog output.
Please do not supply to Pin1–Pin6 of TB2.

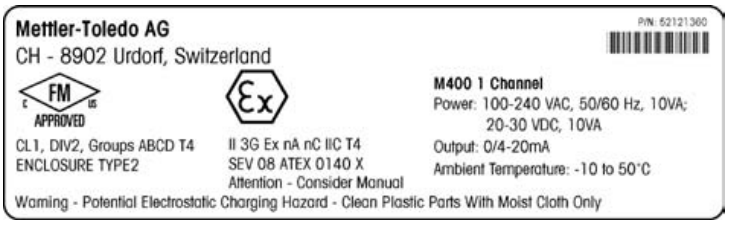
2.2 Correct disposal of the unit

When the transmitter is finally removed from service, observe all local environmental regulations for proper disposal.

2.3 Ex Classification

NOTE: The Ex classification is valid for the transmitters M400 Type 1, M400 Type 2 and M400 Type 3. For the transmitter M400 Type 1 Cond Ind the approvals are in preparation.

Type plate



Special condition(s) X

1. The strength of the device's casing corresponds only to the low degree of mechanical risk and must therefore be additionally protected by suitable measures against mechanical impact effect.
2. Due to the risk of electrostatic charge, the device may only be cleaned with a damp cloth. This instruction is fitted on the device with a separate warning shield stating the following: WARNING – CLEAN PLASTIC PARTS WITH MOIST CLOTH ONLY.
3. In accordance with guideline 94/9/EG separately certified cable and bushes in addition to sealing plugs/caps may be used.
4. Unused openings must be closed with the sealing plugs/caps shown under point 3.

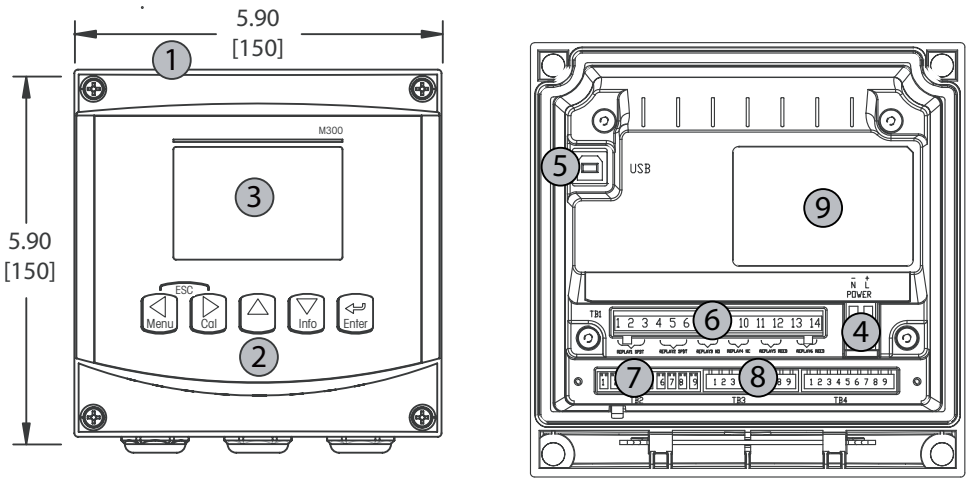
NOTE:

1. The transmitter M400 Type 1, M400 Type 2, M400 Type 3 is a device of device type II category 3G in accordance with RL 94/9/EC (ATEX 95) appendix I, which may be used in accordance with RL 99/32/EG (ATEX 137) in zone 2 and in the gas groups IIA, IIB and IIC, which are explosive because of inflammable materials in the range of temperature classes T1 to T4. During use/installation, the requirements in accordance with EN 60079-14 must be complied with.
2. The permissible ambient temperature range is –10 °C to +50 °C.

3 Unit overview

The M400 models are available in 1/2DIN case size. The M400 models provide an integral IP65 housing for wall- or pipe mount.

3.1 Overview 1/2DIN

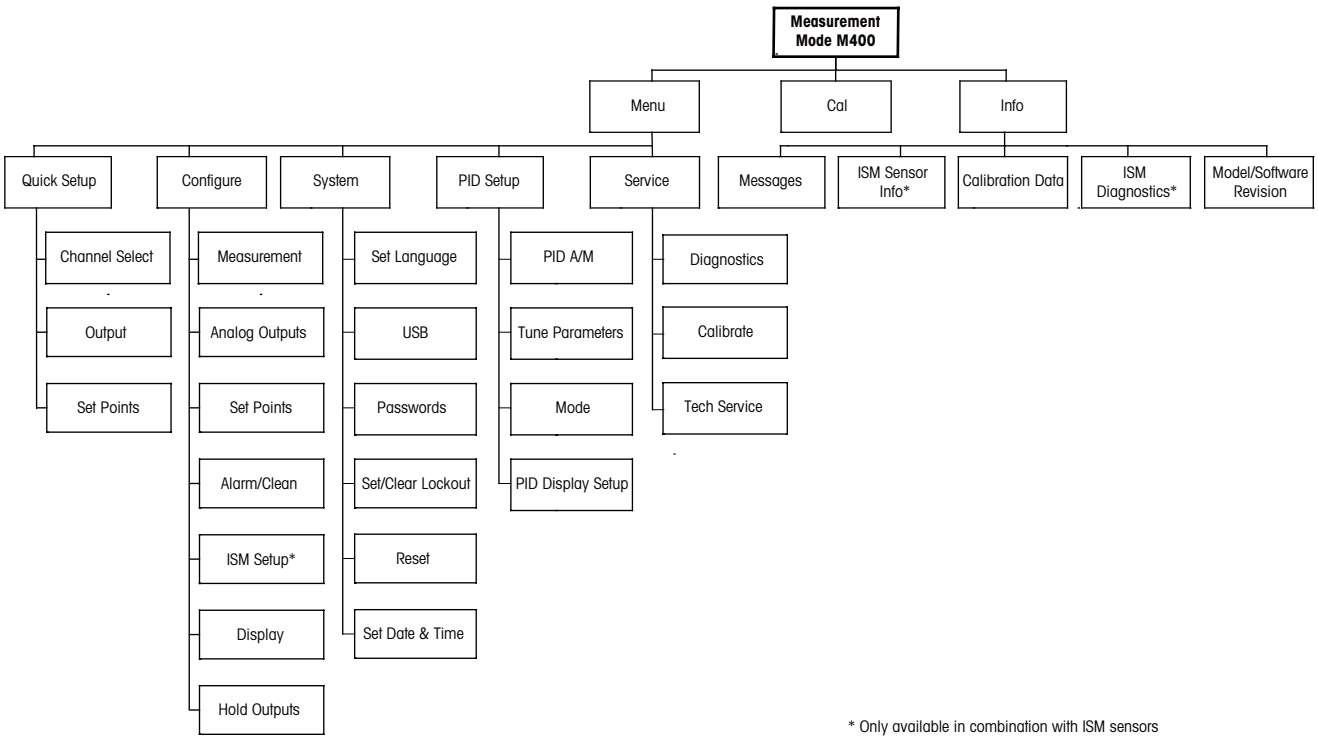


1: Hard Polycarbonate case
2: Five Tactile-Feedback Navigation Keys
3: Four-line LCD Display
4: Power Supply Terminals
5: USB Interface Port
6: Relay Output Terminals
7: Analog Output/Digital Input Terminals
8: Sensor Input Terminals (analog TB, digital TB)
9: List of parameters to be measured with this unit

3.2 Control/Navigation Keys

3.2.1 Menu Structure

Below is the structure of the M400 menu tree:



3.2.2 Navigation keys

3.2.2.1 Navigating the menu tree

Enter the desired main Menu branch with the ◄ ► or ▲ keys. Use the ▲ and ▼ keys to navigate through the selected Menu branch.

☞ **NOTE:** In order to back up one menu page, without escaping to the measurement mode, move the cursor under the UP Arrow character (↑) at the bottom right of the display screen and press [ENTER].

3.2.2.2 Escape

Press the ◀ and ▶ key simultaneously (escape) to return to the Measurement mode.

3.2.2.3 ENTER

Use the ↵ key to confirm action or selections.

3.2.2.4 Menu

Press the ◀ key to access the main Menu.

3.2.2.5 Calibration mode

Press the ▶ key to enter Calibration mode.

3.2.2.6 Info mode

Press the ▼ key to enter Info mode

3.2.3 Navigation of data entry fields

Use the ▶ key to navigate forward or the ◀ key to navigate backwards within the changeable data entry fields of the display.

3.2.4 Entry of data values, selection of data entry options

Use the ▲ key to increase or the ▼ key to decrease a digit. Use the same keys to navigate within a selection of values or options of a data entry field.

NOTE: Some screens require configuring multiple values via the same data field (ex: configuring multiple setpoints). Be sure to use the ▶ or ◀ key to return to the primary field and the ▲ or ▼ key to toggle between all configuration options before entering to the next display screen.

3.2.5 Navigation with ↑ in Display

If a ↑ is displayed on the bottom right hand corner of the display, you can use the ▶ or the ◀ key to navigate to it. If you click [ENTER] you will navigate backwards through the menu (go back one screen). This can be a very useful option to move back up the menu tree without having to exit into the measuring mode and re-enter the menu.

3.2.6 "Save changes" dialog

Three options are possible for the "Save changes" dialog: Yes & Exit (Save changes and exit to measuring mode), "Yes & ↑" (Save changes and go back one screen) and "No & Exit" (Don't save changes and exit to measuring mode). The "Yes & ↑" option is very useful if you want to continue configuring without having to re-enter the menu.

3.2.7 Security Passwords

The M400 transmitter allows a security lock-out of various menus. If the security lock-out feature of the transmitter has been enabled, a security password must be entered to allow access to the menu. See section 9.3 for more information.

3.2.8 Display

NOTE: In the event of an alarm or other error condition the M400 Transmitter will display a flashing ⚠ in the upper right corner of the display. This symbol will remain until the condition that caused it has been cleared.

NOTE: During calibrations (Channel A), clean, Digital In with Analog Output/Relay/USB in Hold state, a flashing "H" (Hold) will appear in the upper left corner of the display. During calibration on Channel B, a flashing "H" (Hold) will appear in the second line. Change to B and flash. This symbol will remain for 20 sec., after end of calibration. This symbol will remain for 20 seconds until after the calibration or clean is completed. This symbol will also disappear when Digital In is deactivated.

NOTE: Channel A (A is shown on the left side of the display) indicates that a conventional sensor is connected to the transmitter.

Channel B (B is shown on the left side of the display) indicates, that an ISM Sensor is connected to the transmitter.

The M400 is a single input channel transmitter, and only one sensor can be connected at the same time.

4 Installation instruction

4.1 Unpacking and inspection of equipment

Inspect the shipping container. If it is damaged, contact the shipper immediately for instructions. Do not discard the box.

If there is no apparent damage, unpack the container. Be sure all items shown on the packing list are present.

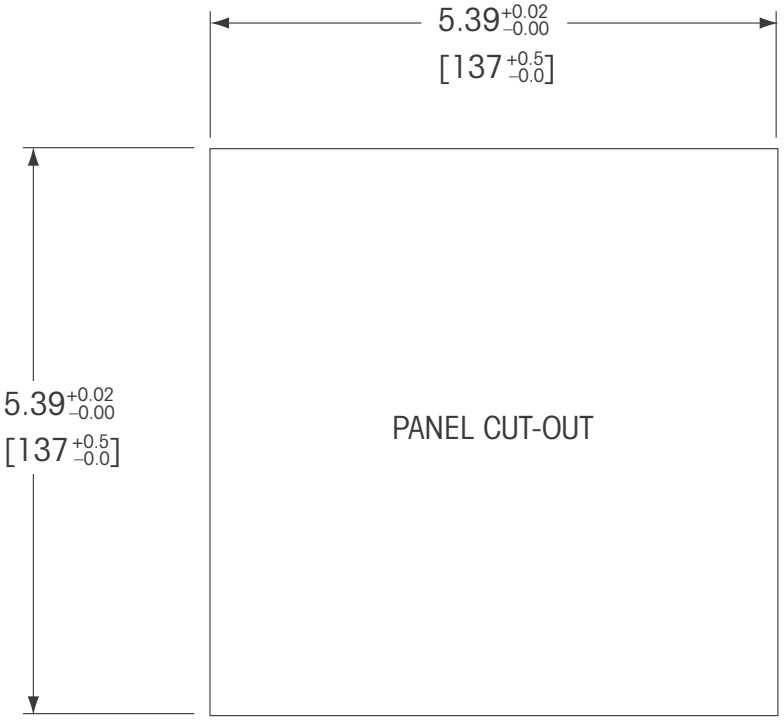
If items are missing, notify Mettler-Toledo immediately

4.1.1 Panel cutout dimensional information – 1/2DIN models

1/2DIN Model transmitters are designed with an integral rear cover for stand-alone wall mount installation.

The unit may also be wall mounted using the integral rear cover. See installation instructions in Section 4.1.2.

Below are cut-out dimensions required by the 1/2DIN models when mounted within a flat panel or on a flat enclosure door. This surface must be flat and smooth. Textured or rough surfaces are not recommended and may limit the effectiveness of the gasket seal provided.



Optional hardware accessories are available that allow for panel- or pipe-mount.
Refer to Section 15 for ordering information.

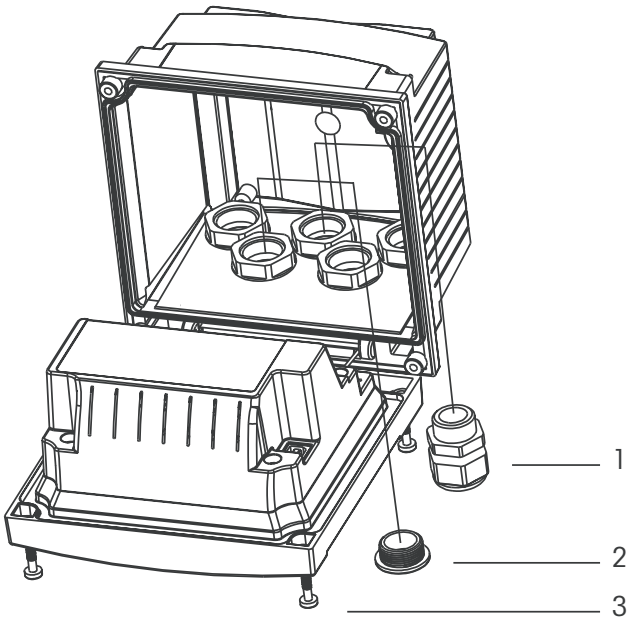
4.1.2 Installation procedure

General:
- Orient the transmitter so that the cable grips face downward.
- Wiring routed through the cable grips shall be suitable for use in wet locations.
- In order provide IP65 enclosure ratings, all cable glands must be in place. Each cable gland must be filled using a cable, or suitable Cable Gland Hole Seal.

For Wall Mount:
- Remove rear cover from front housing.
- Start by unscrewing the four screws located on the face of the transmitter, in each corner. This allows the front cover to swing away from the rear housing.
- Remove the hinge-pin by squeezing the pin from each end. This allows the front housing to be removed from the rear housing
- Mount rear housing to wall. Secure mounting kit to the M400 according to the supplied instructions. Attach to wall using appropriate mounting hardware for wall surface. Be sure it is level and securely fastened and the installation adheres to any and all clearance dimensions required for transmitter service and maintenance. Orient the transmitter so that the cable grips are facing downward.
- Replace the front housing to the rear housing. Securely tighten the rear-cover screws to ensure that IP65 enclosure environmental rating is maintained. The unit is ready to be wired.

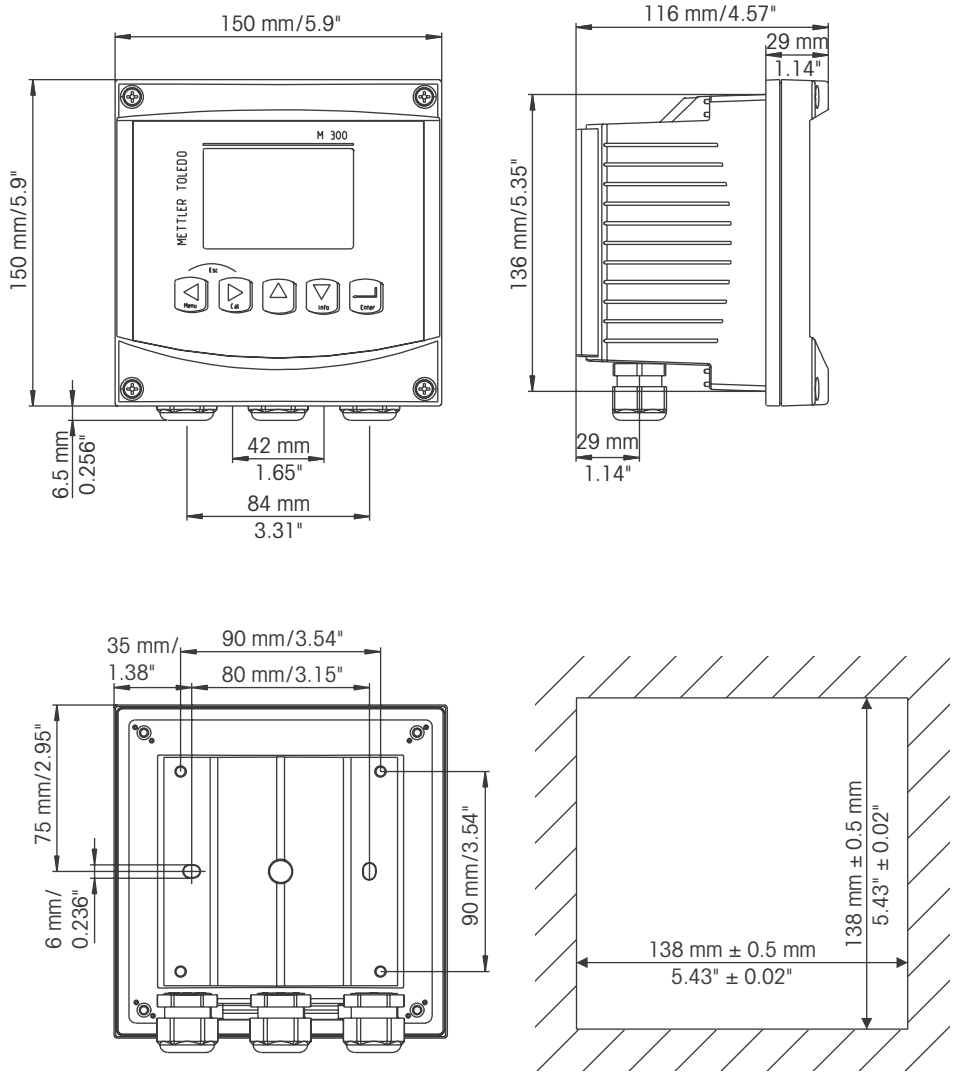
For Pipe Mount:
- Use only manufacturer-supplied components for pipe-mounting the M400 transmitter and install per the supplied instructions. See section 15 for ordering information.

4.1.3 Assembly – 1/2DIN version

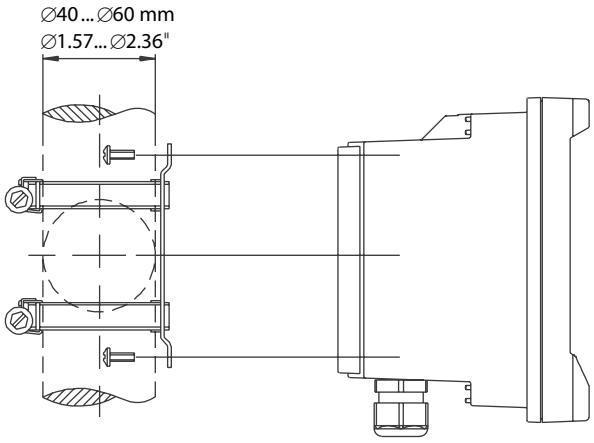


1: 3 Pg 13.5 cable glands
2: 2 plastic plugs
3: 4 screws

4.1.4 1/2DIN version – Dimension drawings



4.1.5 1/2DIN version – Pipe mounting



4.2 Connection of power supply

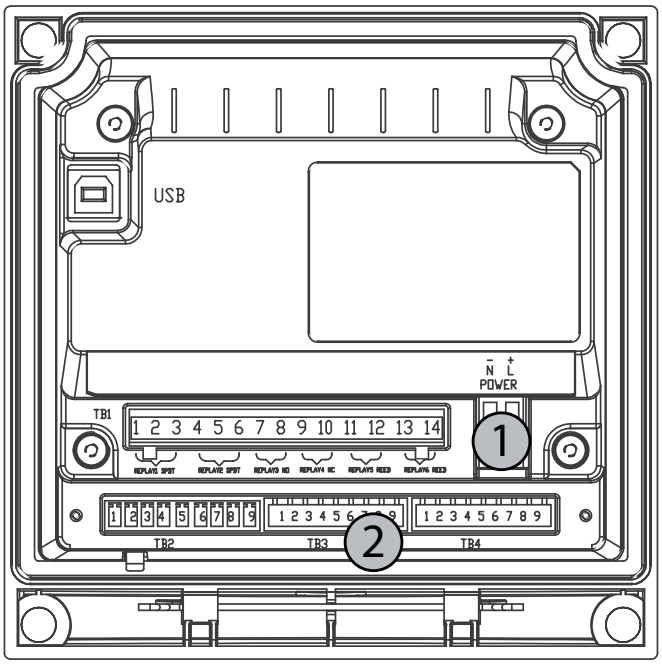
All connections to the transmitter are made on the rear panel of all models.

Be sure power to all wires is turned off before proceeding with the installation. High voltage may be present on the input power wires and relay wires.

A two-terminal connector on the rear panel of all M400 models is provided for power connection. All M400 models are designed to operate from a 20–30 VDC or a 100 to 240 VAC power source. Refer to specifications for power requirements and ratings and size power wiring accordingly (AWG 14, wire cross-section ≤ 2.5 mm^2).

The terminal block for power connections is labeled "Power" on the rear panel of the transmitter. One terminal is labeled **–N** for the Neutral wire and the other **+L** for the Line (or Load) wire. The terminals are suitable for single wires and flexible leads up to 2.5 mm^2 (AWG 14). There is no earth ground terminal on the transmitter. For this reason the internal power wiring within the transmitter is double insulated and the product label designates this using the ⧈ symbol.

4.2.1 Housing (wall mount)



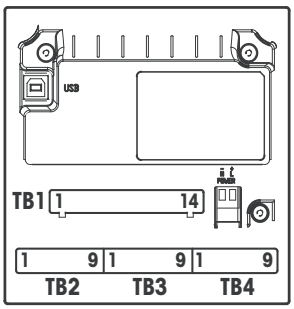
1: Connection of power supply
2: Terminal for sensors

4.3 Connector PIN definition

4.3.1 TB1 and TB2

Power connections are labeled
–N for Neutral and **+L** for Line, for 100 to 240 VAC or 20–30 VDC.

TB2 for ½ DIN	
1	AO1+
2	AO1–/AO2–
3	AO2+
4	AO3+
5	AO3–/AO4–
6	AO4+
7	DI1+
8	DI1–/DI2–
9	DI2+



TB1 for ½ DIN				
1	NO1		8	NC5
2	COM1		9	COM6
3	NC1		10	NO6
4	NO2		11	NO3
5	COM2		12	COM3
6	NC2		13	NO4
7	COM5		14	COM4

NO: normally open (contact open if un-actuated).
NC: normally closed (contact closed if un-actuated).

AO: Analog Output
DI: Digital Input

NOTE: This is a 4-wire-product with an active 4–20 mA analog output.
Please do not supply to Pin1–Pin6 of TB2.

4.3.2 TB3 – Analog resistive 2-e conductivity sensors

Pin no.	Sensor wire color*	Function
1	white	Cnd inner 1
2	white/blue	Cnd outer 1
3	blue	Cnd inner 2
4	black	Cnd outer 2/Shield
5	–	not used
6	bare shield	RTD ret/GND
7	red	RTD sense
8	green	RTD
9	–	+5 V

* Transparent not connected.

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

4.3.3 TB3 – Analog resistive 4-e conductivity sensors

Pin no.	Sensor wire color*	Function
1	white	Cnd inner 1
2	white/blue	Cnd outer 1
3	blue	Cnd inner 2
4	black	Cnd outer 2/Shield
5	–	not used
6	bare shield	RTD ret/GND
7	red	RTD sense
8	green	RTD
9	–	+5V

* Transparent not connected.

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

4.3.4 TB3 – Analog inductive conductivity sensors

Pin no.	Sensor wire color InPro 7250 ST / PFA	Sensor wire color InPro 7250 HT	Function
1	Coax inner/transparent	Coax inner/transparent	receive hi
2	red	yellow	receive lo
3	green/yellow	green/yellow	shield/GND
4	brown	violet	send lo
5	blue	black	send hi
6	white	white	RTD ret/GND
7	grey	grey	RTD sense
8	green	green	RTD
9	–	–	not used

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

4.3.5 TB3 – Analog pH/ORP sensors

pH/ORP sensors use 52 300 1XX series VP cables, or 10 001 XX02 series AS9 cables (ORP only).

Pin no.	Sensor wire color	Function
1	Coax inner/transparent	Glass
2		not used
3*	Coax shield/red	Reference
4*	green/yellow, blue	Solution GND/Shield
5	–	not used
6	white	RTD ret/GND
7	–	RTD sense
8	green	RTD
9	–	+5 V
	grey (no connection)	

Take care that AS9 cable and AK9 cable have the same configuration. So, if you want AS9 cable with InPro 2000 and AK9 cable with InPro 3030 connect to TB3, do it as DPAS sensor.

Pin no. 1: Sensing (electrode).
Pin no. 3: Reference (Install jumper 3 to 4).

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

NOTE: * Install Jumper 3 to 4 when used without Solution Ground.

4.3.6 TB3 – Analog ISFET sensors

ISFET sensors use 52 300 40X series VP cables

Pin no.	Sensor wire color	Function
1	Coax inner/pink	FET
2	–	not used
3	yellow	Reference
4	green/yellow	GND / Shield
5	–	not used
6	white	RTD ret/GND
7	–	not used
8	grey	RTD
9	brown	+5 V

NOTE: Jumper 3 to 4 has to be installed

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

4.3.7 TB3 – Analog oxygen sensors

These sensors use 52 300 1XX series VP cables.

Pin no.	Sensor wire color	Function
1*	–	not used
2	Coax Shield/red	Anode
3*	–	not used
4*	green/yellow	Shield/GND
5	Coax Inner/transparent	Cathode
6	white, grey	Temperature, Guard
7	–	not used
8	green	Temperature
9	–	+5 V

Blue wire not used.

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

NOTE: * Install jumper (supplied) 1 to 3 to 4 when using InPro 6900 (ppb measurement).

4.3.8 TB3 – Analog dissolved carbon dioxide sensors

Dissolved carbon dioxide sensors use 52 300 1XX series VP cables.

Pin no.	Sensor wire color	Function
1	Coax inner/transparent	Glass
2	–	not used
3	Coax shield/red	Reference
4	green/yellow	GND/Shield
5	–	not used
6	white	RTD ret/GND
7	–	not used
8	green	RTD
9	–	+5 V
	grey (no connection)	

NOTE: Jumper 3 to 4 has to be installed

Terminal 4 and 6 are internally connected, either terminal can be used to connect a wire.

4.3.9 TB4 – ISM (digital) sensors for pH, conductivity and oxygen

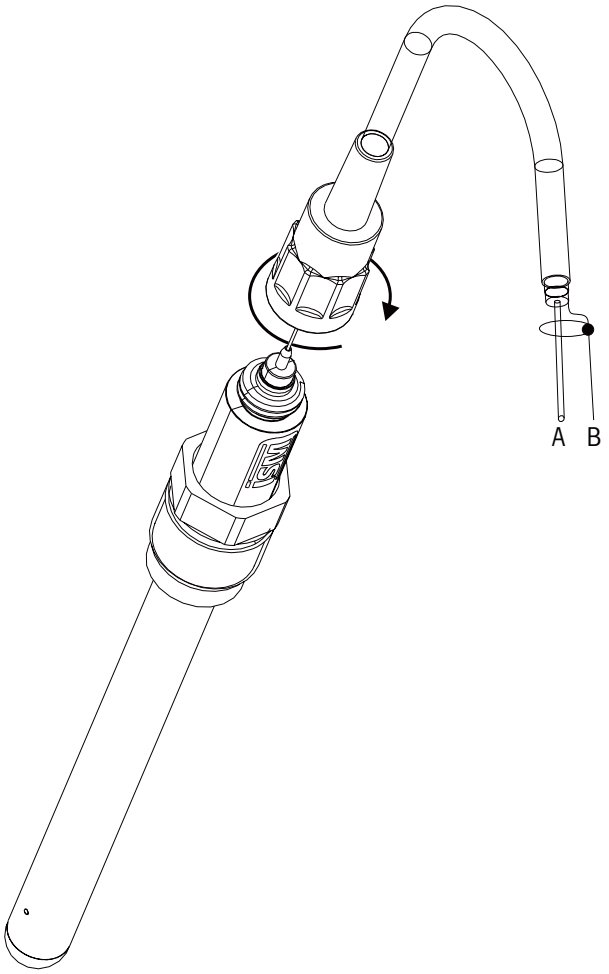
The wiring of the digital 9 terminal connectors is:

		Optical Oxygen	**pH, amp. Oxygen, Cond 4-e**
Pin no.	**Function**	**Sensor wire color**	**Sensor wire color**
1	24 VDC	brown	–
2	GND (24 VDC)	black	–
3	1-Wire	–	transparent (cable core)
4	GND (5 VDC)	grey and yellow	red (shield)
5	–	–	–
6	GND (5 VDC)	–	–
7	RS485-B	blue	–
8	RS485-A	white	–
9	5 VDC	–	–

– ISM digital sensors can only be connected on TB4.
– Analog sensors can only be connected on TB3.

4.4 Connection of ISM (digital) sensors

4.4.1 Connection of ISM sensors for pH/ORP, Cond 4-e and amperometric oxygen measurement

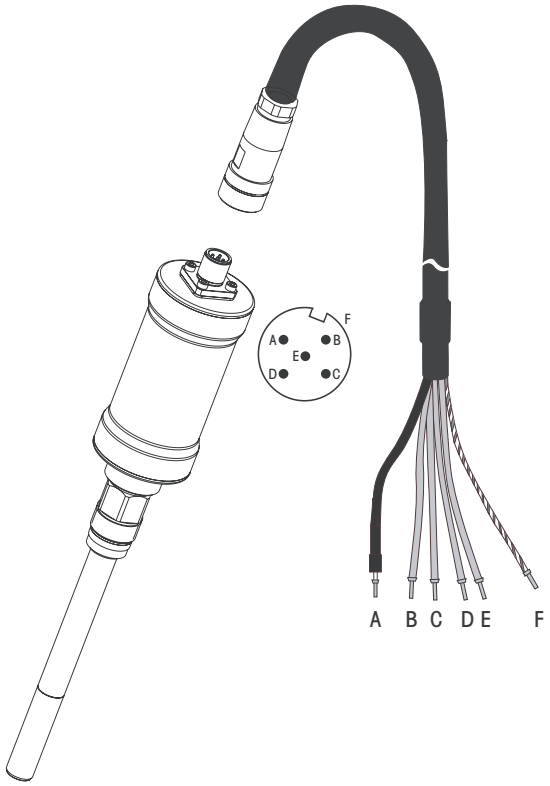


NOTE: Connect the sensor and screw the plug head clockwise (hand tight).

4.4.2 TB4 – AK9 cable assignment

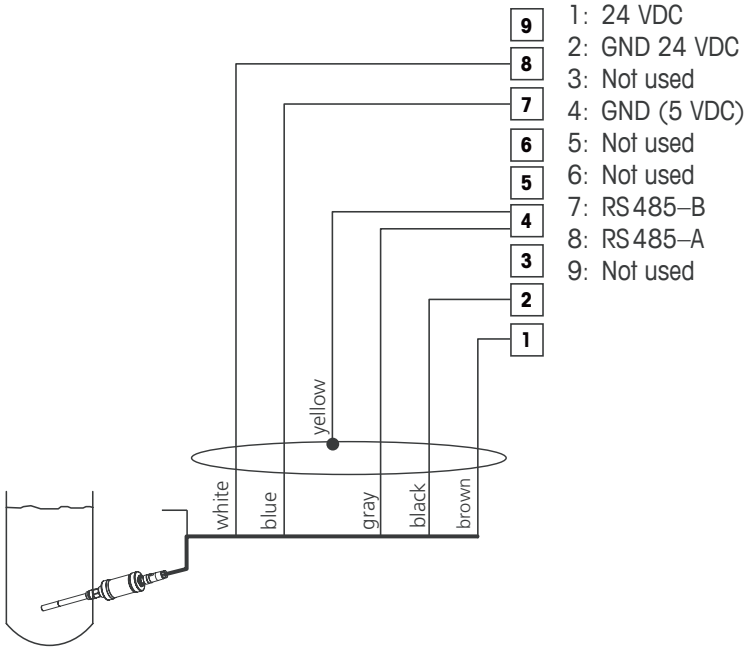
A: 1-wire data (transparent)
B: Ground/shield

4.4.3 Connection of ISM sensor for optical oxygen measurement



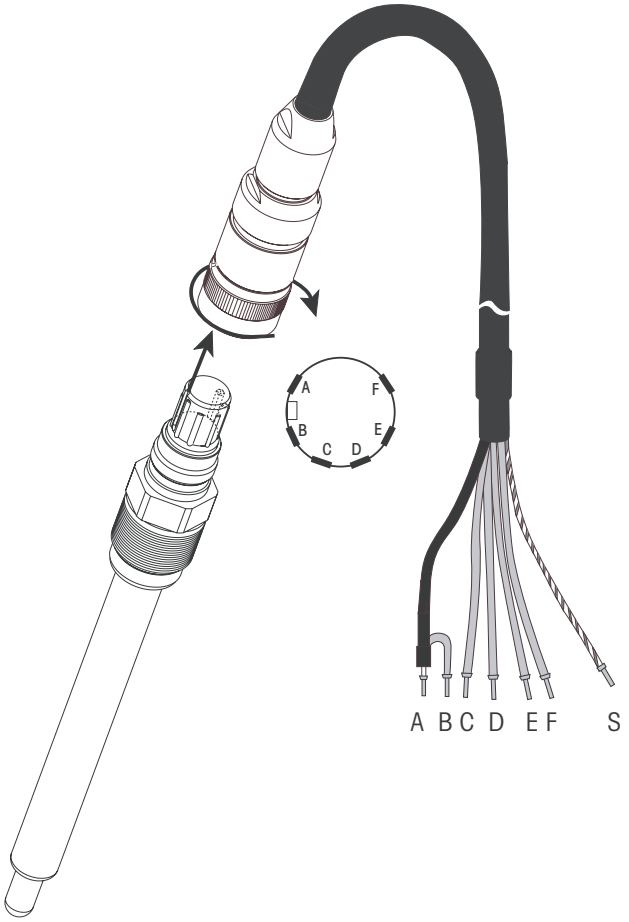
NOTE: Connect the Sensor and screw the plug head clockwise (hand tight).

4.4.4 TB4 – Optical DO sensor cable assignment



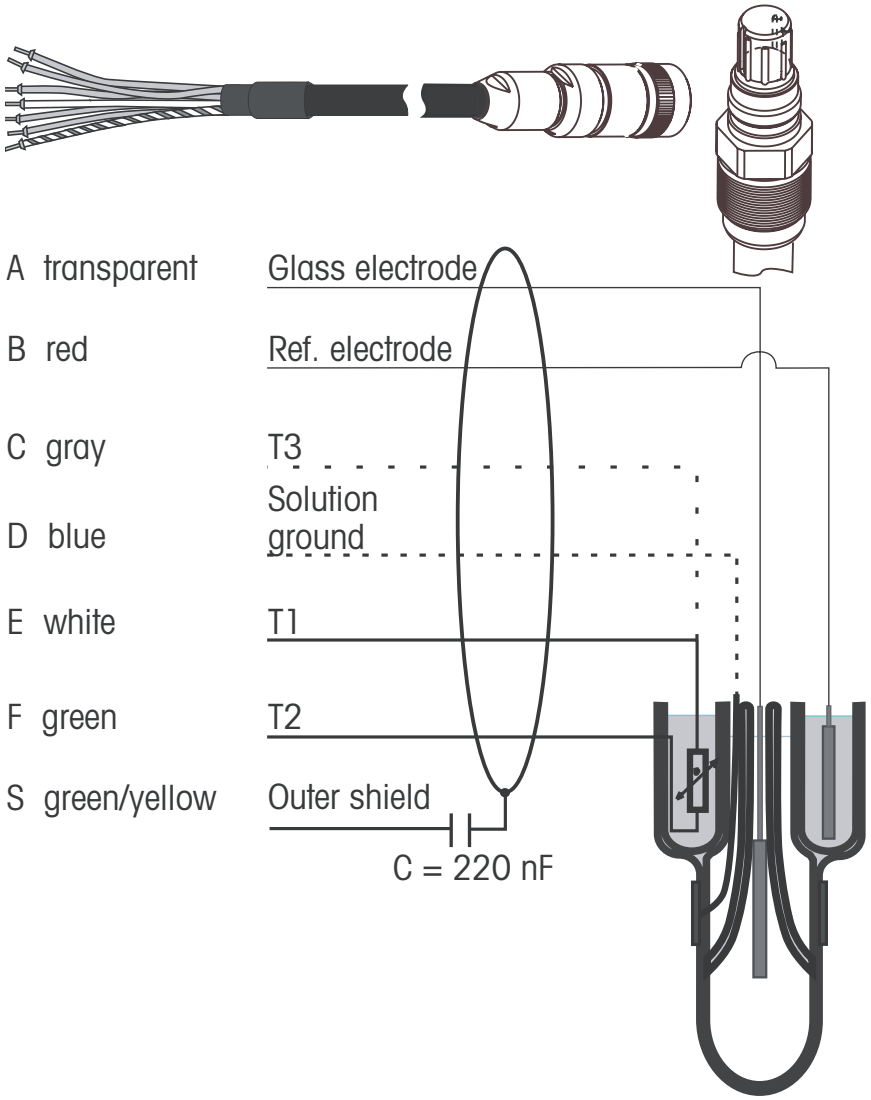
4.5 Connection of analog sensors

4.5.1 Connection of analog sensor for pH/ORP



NOTE: Cable lengths > 20 m can worsen the response during pH measurement. Be sure to observe the sensor instruction manual.

4.5.2 VP cable assignment for pH/ORP sensor

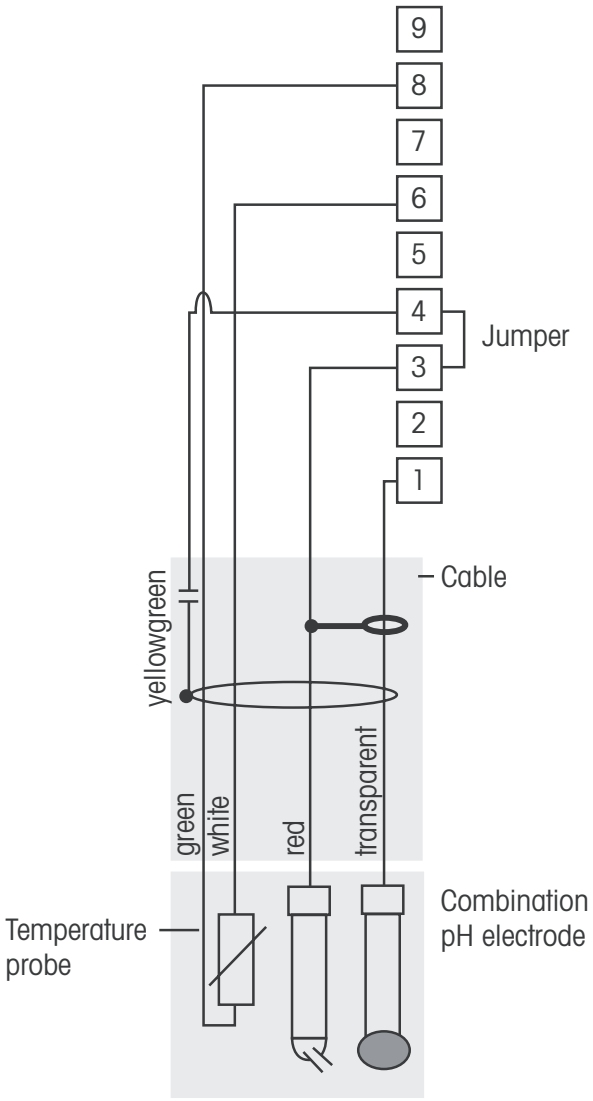


T1/T2: Temperature probe for 2-wire connection
T3: Additional connection for temperature probe (3-wire connection)

4.5.3 TB3 – Typical wiring for analog pH/ORP sensor

4.5.3.1 Example 1

pH measurement without Solution Ground

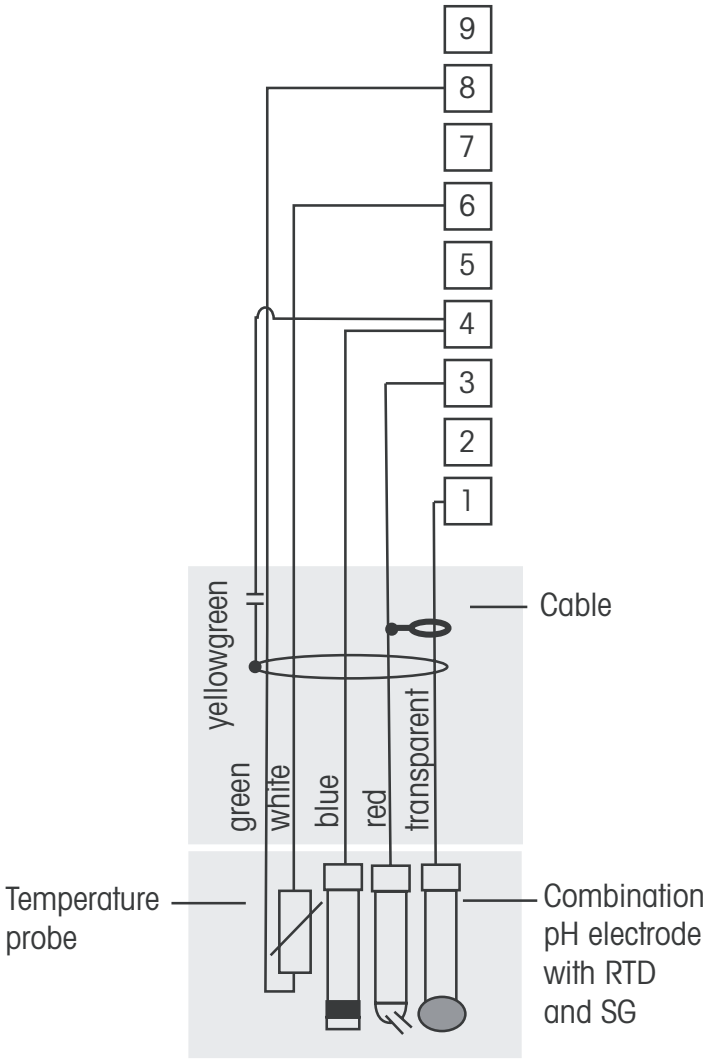


NOTE: Jumper terminals 3 and 4.

Wire colors only valid for connection with VP cable; blue and grey not connected.
1: Glass
2: Not used
3: Reference
4: Shield/GND
5: Not used
6: Solution GND/RTD ret
7: Not used
8: RTD
9: Not used

4.5.3.2 Example 2

pH measurement with Solution Ground

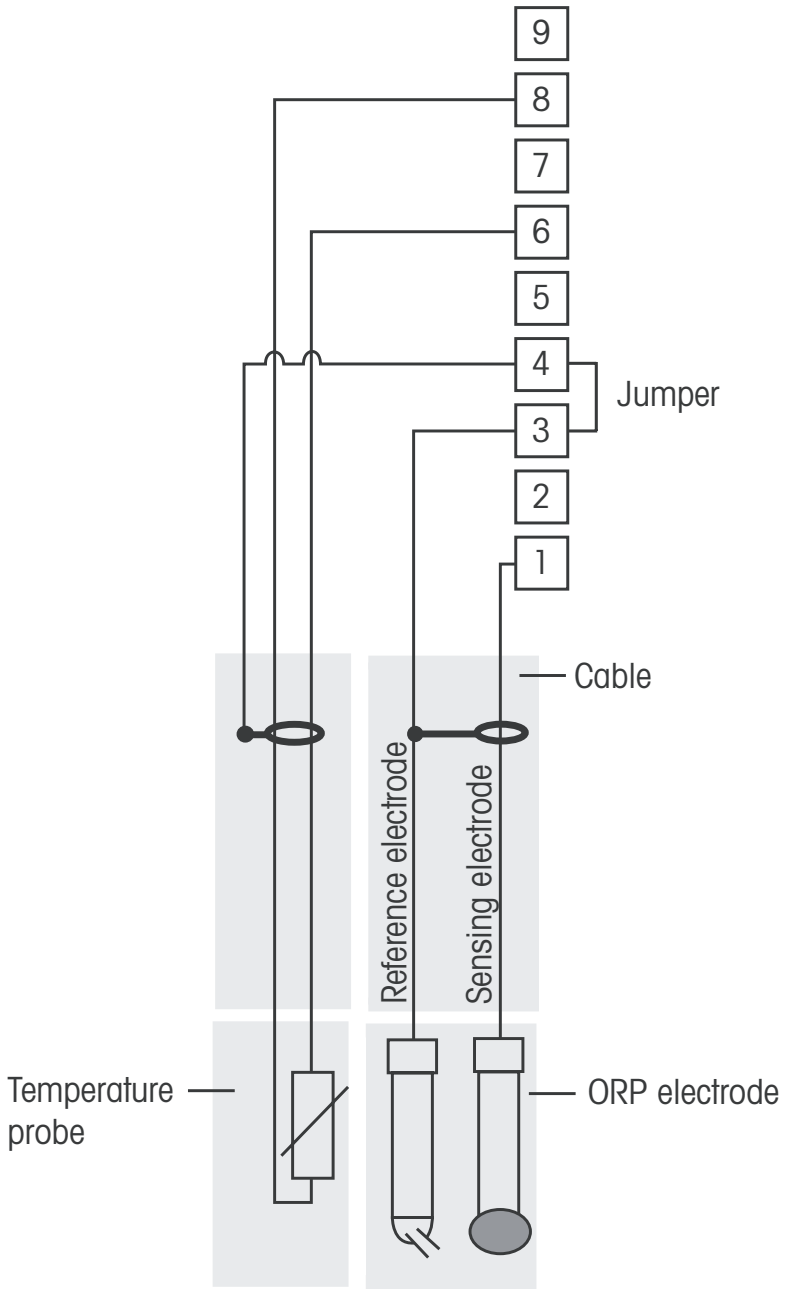


NOTE: Wire colors only valid for connection with VP cable, grey not connected.

1: Glass
2: Not used
3: Reference
4: Shield/Solution GND
5: Not used
6: GND/RTD ret
7: Not used
8: RTD
9: Not used

4.5.3.3 Example 3

ORP (redox) measurement (temperature optional)

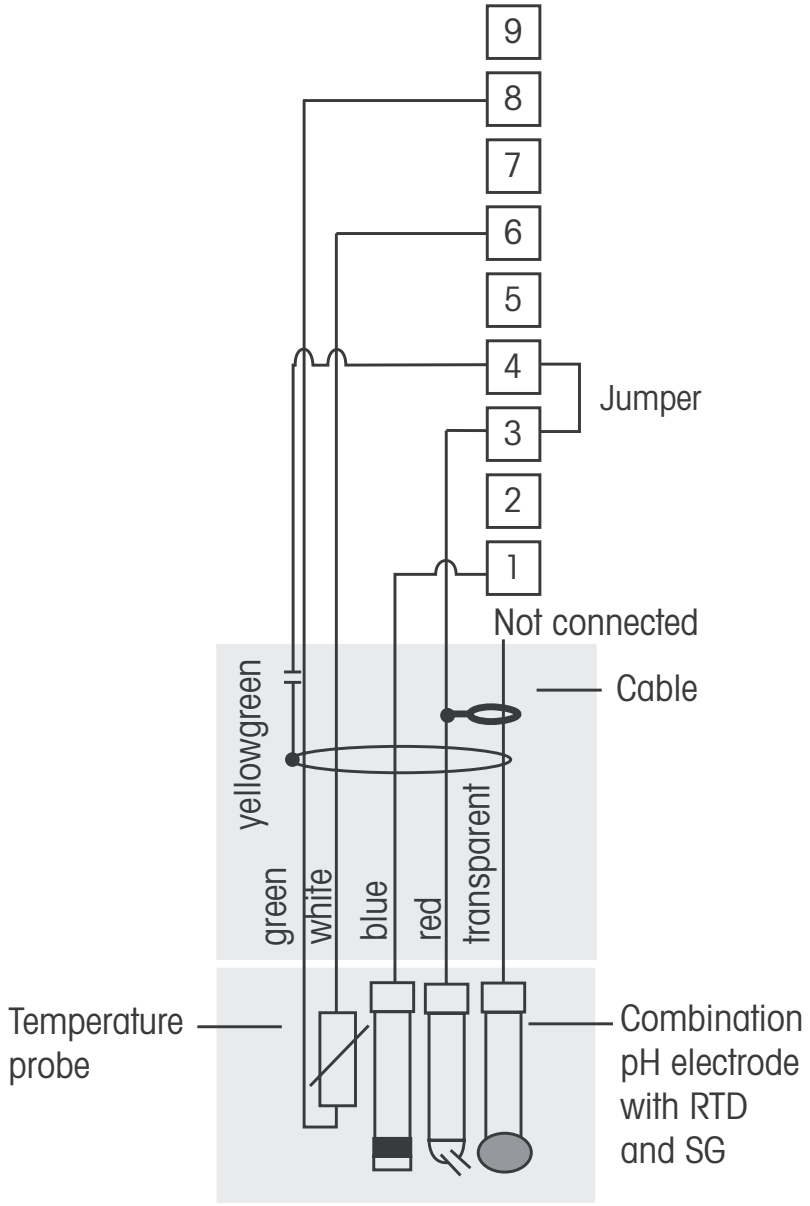


NOTE: Jumper terminal 3 and 4

1: Platinum
2: Not used
3: Reference
4: Shield/GND
5: Not used
6: RTD ret
7: Not used
8: RTD
9: Not used

4.5.3.4 Example 4

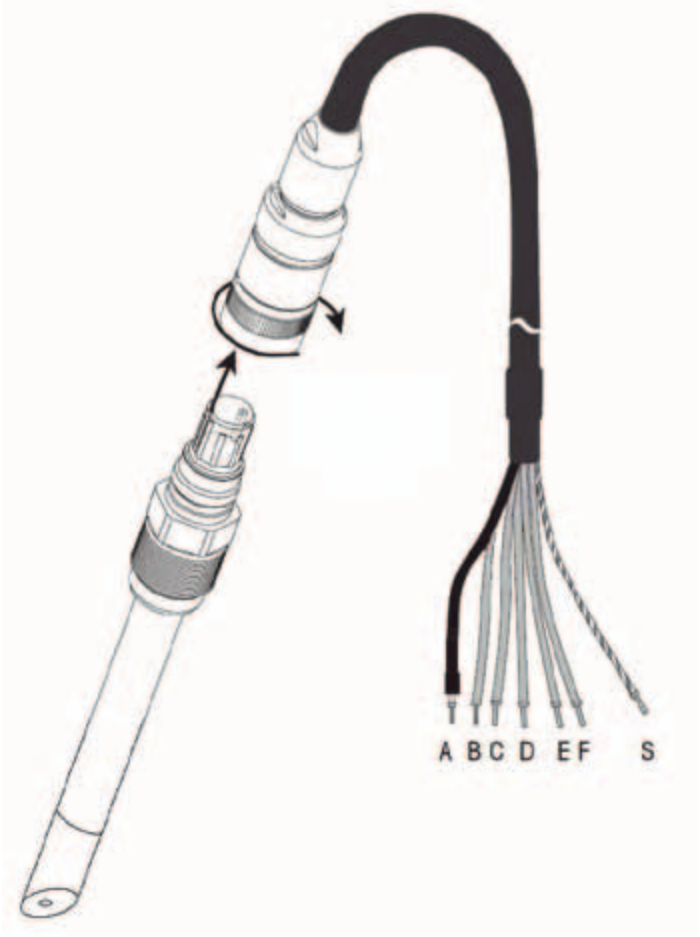
ORP measurement with pH Solution ground electrode (e.g. InPro 3250SG, InPro 4800SG).



NOTE: Jumper terminal 3 and 4

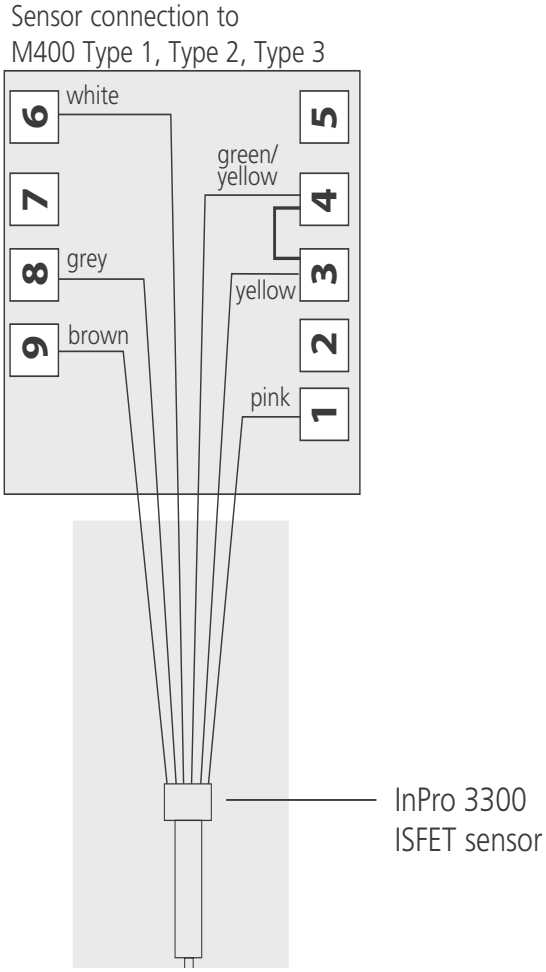
1: Platinum
2: Not used
3: Reference
4: Shield/GND
5: Not used
6: RTD ret
7: Not used
8: RTD
9: Not used

4.5.4 Connection of analog ISFET sensor



NOTE: Be sure to observe the sensor instruction manual.

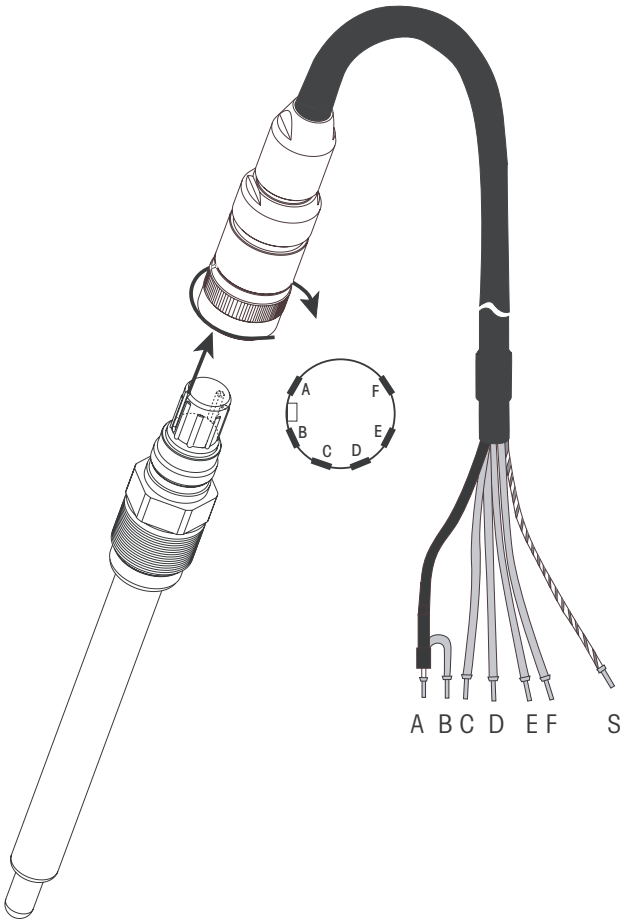
4.5.5 TB3 – Typical wiring for analog ISFET sensor



NOTE: Jumper Terminal 3 and 4 has to be installed.

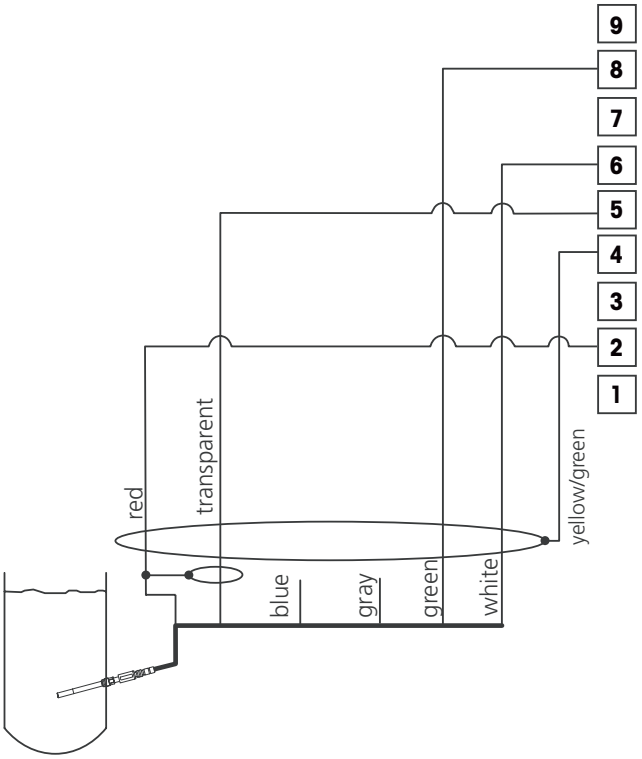
M400 connector:
1: FET
2: not used
3: Reference
4: Shield/GND
5: not used
6: RTD ret/GND
7: not used
8: RTD
9: +5 VDC

4.5.6 Connection of analog sensor for amperometric oxygen measurement



NOTE: Be sure to observe the sensor instruction manual.

4.5.7 TB3 – Typical wiring for analog sensor for amperometric oxygen measurement

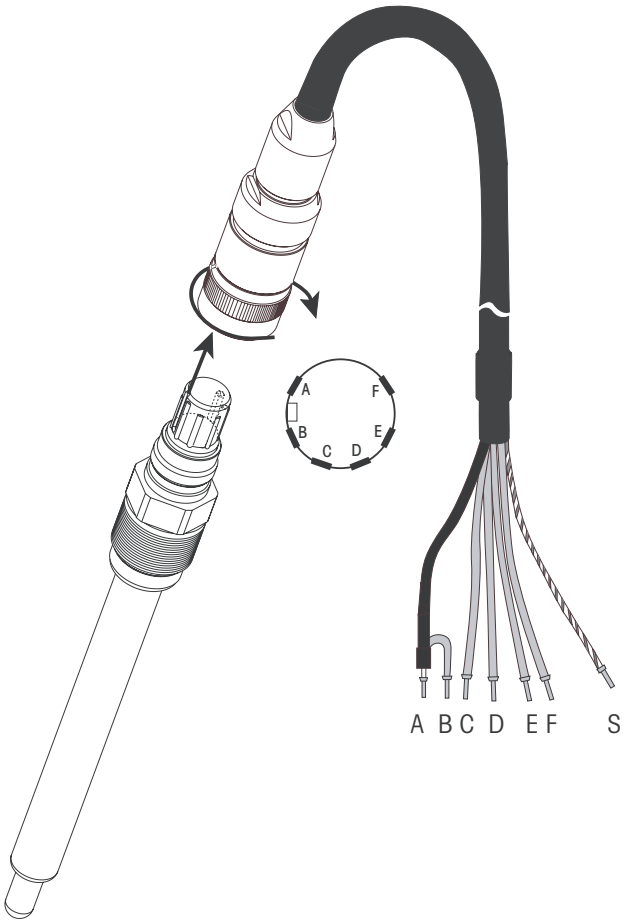


NOTE: Wire colors only valid for connection with VP cable, blue not connected.

NOTE: Install jumper (supplied) 1 to 3 to 4 when using InPro 6900 (ppb measurement).

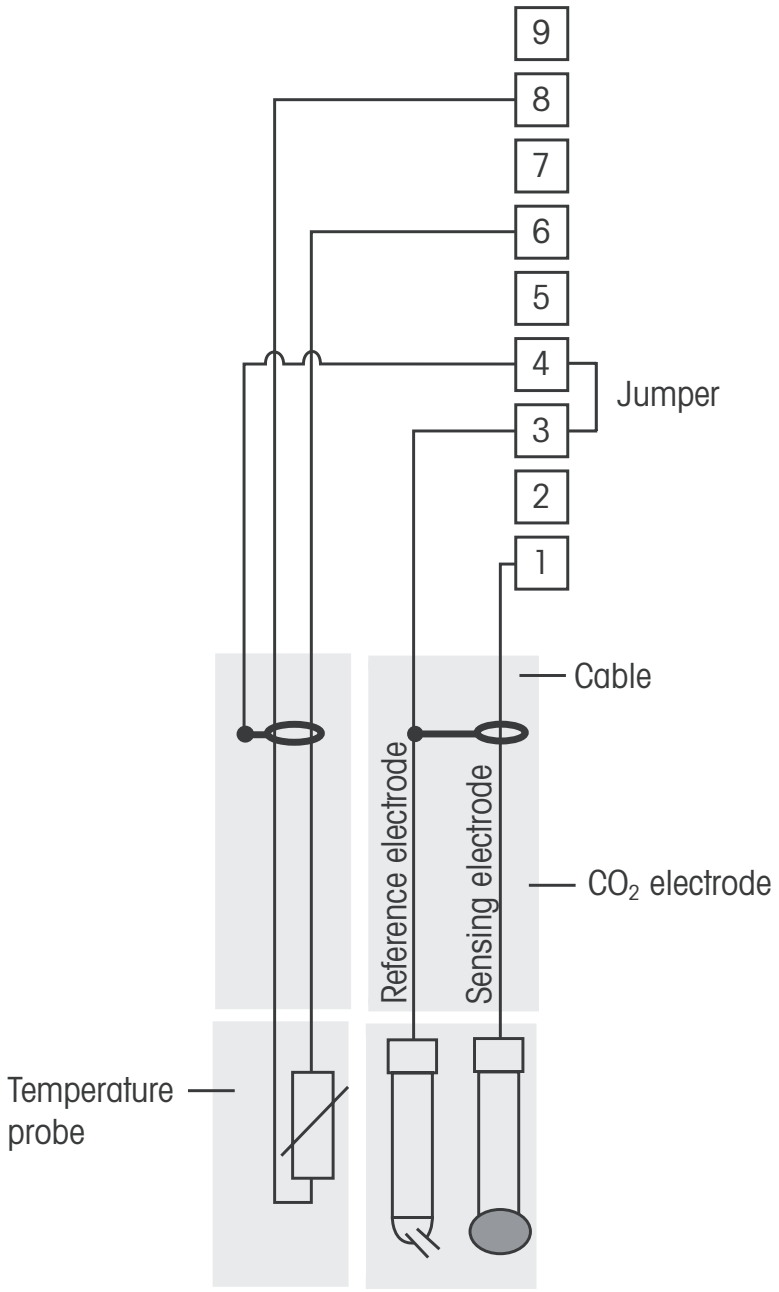
M400 connector:
1: Not used
2: Anode
3: Not used
4: Shield/GND
5: Cathode
6: NTC ret, Guard
7: Not used
8: NTC 2
9: Not used

4.5.8 Connection of analog sensor for dissolved carbon dioxide



NOTE: Cable lengths > 20 m can worsen the response during dissolved carbon dioxide measurement. Be sure to observe the sensor instruction manual.

4.5.9 TB3 – Typical wiring for analog dissolved carbon dioxide sensor



NOTE: Jumper Terminal 3 and 4 has to be installed.

M400 connector:
1: Glass
2: not used
3: Reference
4: Shield/GND
5: not used
6: RTD ret/GND
7: not used
8: RTD
9: not used

5 Placing transmitter in, or out, of service

5.1 Placing transmitter in service

After connecting the transmitter to power supply circuit, it will be active as soon as the circuit is powered.

5.2 Placing transmitter out of service

First disconnect the unit from the main power source, then disconnect all remaining electrical connections. Remove the unit from the wall/panel. Use the installation instruction in this manual as reference for dis-assembling mounting hardware.

All transmitter settings stored in memory are non volatile.

6 Quick Setup

(PATH: Menu/Quick Setup)

Select Quick Setup and press the [ENTER] key. Enter the security code if necessary (see section 9.3 "Passwords")

Note: Please find the complete description of the Quick Setup routine described in the separate booklet "Quick Setup Guide for Transmitter M400" enclosed in the box.

Note: Refer to section 3.2 "Control/Navigation Keys" for information on menu navigation.

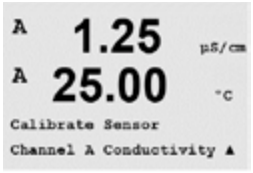
7 Sensor Calibration

(PATH: Cal)

The calibration key ▶ allows the user one-touch access to sensor calibration and verification features.

NOTE: During Calibration on Channel A, a flashing "H" (Hold) in the upper left corner of the display indicates a calibration is in process with a Hold condition active. (The hold output function needs to be activated.) See also chapter 3.3 "Display".

7.1 Enter Calibration Mode



While in Measurement mode press the ▶ key. If the display prompts you to enter the calibration security code, press the ▲ or ▼ key to set the calibration security mode, then press the [ENTER] key to confirm the calibration security code.

Press the ▲ or ▼ key to select the type of calibration desired.

Select the desired sensor Calibration task. The choices for each sensor type are:
Conductivity = Conductivity, Resistivity*, Temperature**, Edit**, Verify
Oxygen = Oxygen, Temperature**, Edit**, Verify
O2 opt = Oxygen***, Verify***
pH = pH, mV**, Temperature**, Edit pH**, Edit mV**, Verify, ORP***
ISFET = ISFET**, Temperature**, Edit ISFET**, mV**, Edit mV**, Verify**,
CO_2 = CO2**, Temperature**, Edit**, Verify**
Press [ENTER].

* not available at M400 Type 1 Cond Ind
** only on channel "A"
*** only available on channel "B"

After every successful calibration, the three options are available:
Adjust: Calibration values will be overtaken und used for the measurement. Additionally, the data will be stored in the calibration history*.
Calibrate: Calibration values will be stored in the calibration history* for documentation, but will not be used for the measurement. The calibration values from the last valid adjustment will be further used for the measurement.
Abort: Calibration values will be discarded.

* only available with ISM sensors

7.2 Conductivity calibration for two- or four-electrode sensors

This feature provides the ability to perform a one-point, two-point or process Conductivity resp. Resistivity "Sensor" calibration for two- or four-electrode sensors. The procedure described below works for both types of calibrations. There is no reason to perform a two-point calibration on a two-electrode conductivity sensor. Four electrode sensors do require a two-point calibration.

NOTE: When performing calibration on a conductivity sensor, results will vary depending on the methods, calibration apparatus and/or quality of reference standards used to perform the calibration.

NOTE: For measuring tasks the temperature compensation for the application as defined at the menu Resistivity will be considered and not the temperature compensation selected thru the calibration procedure (see also chapter 8.2.3.1 "Conductivity temperature compensation"; PATH: Menu/Configure/Measurement/Resistivity).

Enter Conductivity sensor calibration mode as described in section 7.1 "Enter Calibration Mode".

The next screen will ask to select the type of temperature compensation mode desired during the calibration process.

Choices are "Standard", "Lin 25 °C", "Lin 20 °C" or "Nat H_2O" compensation mode.

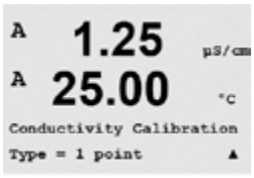
Standard compensation:	includes compensation for non-linear high purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.
Lin 25°C compensation:	adjusts the reading by a factor expressed as "% per °C" deviation from 25 °C. The factor can be modified.
Lin 20°C compensation:	adjusts the reading by a factor expressed as "% per °C" deviation from 20 °C. The factor can be modified.
Nat H_2O compensation:	includes compensation to 25 °C according to EN27888 for natural water.

Choose the compensation mode, modify the factor where appropriate and press [ENTER].

7.2.1 One-point sensor calibration

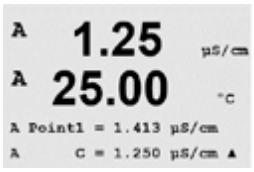
(Display reflects typical Conductivity Sensor calibration)

Enter Conductivity Sensor Calibration mode as described in section 7.1 "Enter Calibration Mode" and choose one of the compensation modes (see section 7.2 "Conductivity calibration for two- or four electrode sensors").



Select 1 point calibration and press [ENTER]. With conductivity sensors a one-point calibration is always performed as a slope calibration.

Place the electrode into the reference solution.



Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter and sensor in the units selected by the user. Press [ENTER] when this value is stable to perform the calibration.

After the calibration the cell multiplier or slope calibration factor "M" i.e. cell constant and the Adder or offset calibration factor "A" are displayed.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

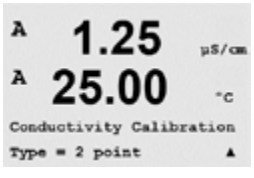
* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.2.2 Two-point sensor calibration (four electrode sensors only)

(Display reflects typical Conductivity sensor calibration)

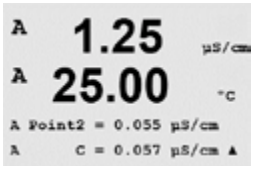
Enter Conductivity Sensor Calibration mode as described in section 7.1 "Enter Calibration Mode" and choose one of the compensation modes (see section 7.2 "Conductivity calibration for two- or four electrode sensors").



Select 2 point calibration and press [ENTER].

Place the electrode into the first reference solution.

CAUTION: Rinse sensors with a high-purity water solution between calibration points to prevent contamination of the reference solutions.



Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter and sensor in the units selected by the user. Press [ENTER] when this value is stable and place the electrode into the second reference solution.

Enter the value for Point 2 including a decimal point and units. The value in the second text line is the value being measured by the transmitter and sensor in the units selected by the user. Press [ENTER] when this value is stable to perform the calibration.

After the calibration of the cell multiplier or slope calibration factor "M" i.e. cell constant and the Adder or offset calibration factor "A" are displayed.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

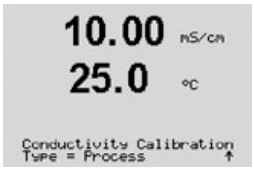
* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.2.3 Process Calibration

(Display reflects typical Conductivity sensor calibration)

Enter Conductivity Sensor Calibration mode as described in section 7.1 "Enter Calibration Mode" and choose one of the compensation modes (see section 7.2 "Conductivity calibration for two- or four electrode sensors").

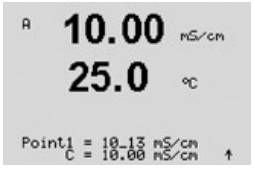


Select Process Calibration and press [ENTER]. With conductivity sensors a process calibration is always performed as a slope calibration.

Take a sample and press the [ENTER] key again to store the current measuring value.

During the ongoing calibration process, the letter of the channel, which is concerned by the calibration, "A" or "B" is blinking in the display.

After determining the conductivity value of the sample, press the [CAL] key again to proceed with the calibration.



Enter the conductivity value of the sample, then press the [ENTER] key to start the calculation of calibration results.

After the calibration the Multiplier or slope calibration factor "M" and the Adder or offset calibration factor "A" are displayed.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

* only available with ISM sensor. The values will be stored in the sensor.

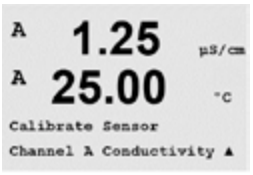
If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. The M400 returns to the measuring mode.

7.3 Conductivity calibration for inductive sensors

This feature provides the ability to perform a one-point offset, one-point slope or process calibration for the inductive conductivity sensors. This feature is only available at the M400 Type 1 Cond Ind.

NOTE: When performing calibration on a conductivity sensor, results will vary depending on the methods, calibration apparatus and/or quality of reference standards used to perform the calibration.

NOTE: For measuring tasks the temperature compensation for the application as defined at the menu Resistivity will be considered and not the temperature compensation selected thru the calibration procedure (see also chapter 8.2.3.1 "Conductivity temperature compensation"; PATH: Menu/Configure/Measurement/Resistivity).



Enter Conductivity sensor calibration mode as described in section 7.1 "Enter Calibration Mode".

The next screen will ask to select the type of temperature compensation mode desired during the calibration process.

Choices are "Standard", "Lin 25°C", "Lin 20°C" or "Nat H2O" compensation mode.

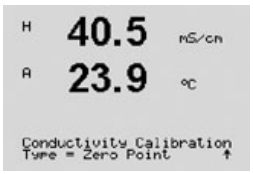
Standard compensation:	includes compensation for non-linear high purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.
Lin 25 °C compensation:	adjusts the reading by a factor expressed as "% per °C" at a deviation from 25 °C. The factor can be modified.
Lin 20 °C compensation:	adjusts the reading by a factor expressed as "% per °C" at a deviation from 20 °C. The factor can be modified.
Nat H_2O compensation:	includes compensation to 25 °C according to EN27888 for natural water.

Choose the compensation mode, modify the factor where appropriate and press [ENTER].

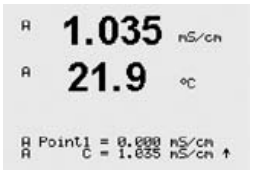
7.3.1 Zero-point calibration

(Display reflects typical Conductivity sensor calibration)

Enter Conductivity Sensor Calibration mode as described in section 7.1 "Enter Calibration Mode" and choose one of the compensation modes (see section 7.3 "Conductivity calibration for inductive sensors").



Select Zero Point and press [ENTER].



Press the [ENTER] key again to go on with the calibration.

The display changes to show the multiplier or slope calibration factor "M" i.e. cell factor and the adder or offset calibration factor "A".

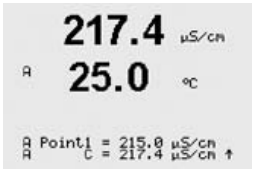
After a successful calibration, the calibration values are taken over (Adjust) or discarded (Calibrate) or (Abort).

If "Adjust" is chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.3.2 One-point slope calibration

Enter Conductivity Sensor Calibration mode as described in section 7.1 "Enter Calibration Mode" and choose one of the compensation modes (see section 7.3 "Conductivity calibration for inductive sensors").

Select 1 point Slope and press [ENTER].



Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter and sensor in the units selected by the user. Press [ENTER] when this value is stable to perform the calibration.

The display changes to show the multiplier or slope calibration factor "M" i.e. cell factor and the adder or offset calibration factor "A".

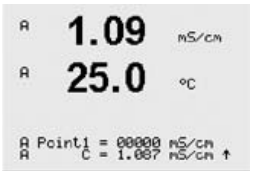
After a successful calibration, the calibration values are taken over (Adjust) or discarded (Calibrate) or (Abort).

If "Adjust" is chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press Enter" on the display. After pressing "Enter" the M400 returns to the measuring mode.

7.3.3 Process calibration

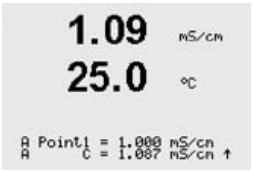
Enter Conductivity Sensor Calibration mode as described in section 7.1 "Enter Calibration Mode" and choose one of the compensation modes (see section 7.3 "Conductivity calibration for inductive sensors").

Select Process and press [ENTER].



Take a sample and press the [ENTER] key again to store the current measuring value. During the ongoing calibration process, "A" is blinking in the display.

After determining the conductivity value of the sample, press the [CAL] key again to proceed with the calibration.



Enter the conductivity value of the sample, then press the [ENTER] key to start the calculation of calibration results.

After a successful calibration, the calibration values are taken over (Adjust) or discarded (Calibrate) or (Abort).

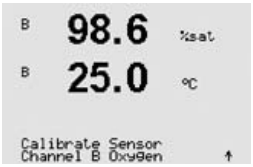
If "Adjust" is chosen, the message "Calibration successful" is displayed. The M400 returns to the measuring mode.

7.4 Calibration of amperometric oxygen sensors

Oxygen calibration for amperometric sensors is performed as either a one-point or process calibration.

☞ **NOTE:** Before air calibration, for highest accuracy, enter the barometric pressure and relative humidity, as described in section 8.2.3.4 "Oxygen parameters".

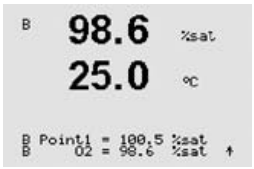
7.4.1 One-point calibration for amperometric oxygen sensors



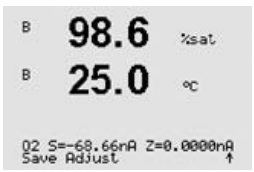
Enter Oxygen calibration mode as described in section 7.1 "Enter Calibration Mode".

A one-point calibration of oxygen sensors is always either a one point slope (i.e. with air) or a zero (offset) calibration. A one point slope calibration is done in air and a one point offset calibration is done at 0 ppb oxygen. A one-point zero dissolved oxygen calibration is available but not normally recommended since zero oxygen is very hard to achieve. A zero-point calibration is only recommended if high accuracy at low oxygen level (below 5% air) is needed.

Select 1 point followed by either Slope or ZeroPt as the calibration type.
Press [ENTER].



Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter and sensor in the units selected by the user.
Press [ENTER] when this value is stable to perform the calibration.



After the calibration the slope "S" and the offset value "Z" are displayed.

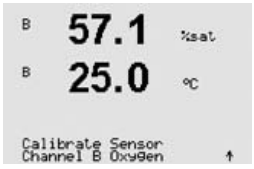
In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

NOTE: With ISM sensors: If a one point calibration is executed, the transmitter sends the polarization voltage, valid for the calibration, to the sensor. If the polarization voltage for the measuring mode and calibration mode is different, the transmitter will wait 120 seconds before starting the calibration. In this case the transmitter will also go after the calibration for 120 seconds to the HOLD Mode, before returning to the measuring mode again. (see also chapter 8.2.3.4 "Parameter for oxygen measurement based on amperometric sensors")

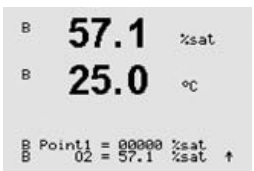
7.4.2 Process calibration for amperometric oxygen sensors



Enter Oxygen calibration mode as described in section 7.1 "Enter Calibration Mode".

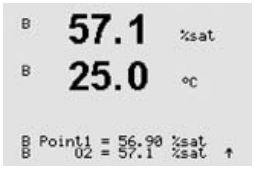
A process calibration of oxygen sensors is always either a slope or a offset calibration.

Select Process followed by either Slope or ZeroPt as the calibration type. Press [ENTER]



Take a sample and press the [ENTER] key again to store the current measuring value. To show the ongoing calibration process, A or B (depending on the channel) is blinking in the display.

After determining the O_2 value of the sample press the ▶ key again to proceed with the calibration.



Enter the O_2 value of the sample then press the [ENTER] key to start the calculation of the calibration results.

After the calibration the slope "S" and the offset value "Z" are displayed.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. The M400 returns to the measuring mode.

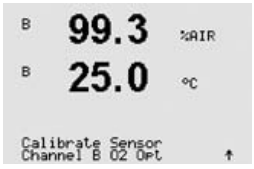
7.5 Calibration of optical oxygen sensors

Oxygen calibration for optical sensors can be performed as a two-point, process or, depending on the sensor model connected to the transmitter, also as a one-point calibration.

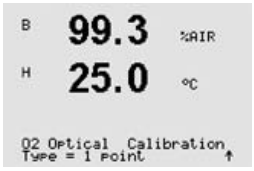
7.5.1 One-point calibration for optical oxygen sensors

Typically a one point calibration is done in air. Nevertheless other calibration gases and solutions are possible.

The calibration of an optical sensor is always a calibration of the phase of the fluorescence signal towards the internal reference. During a one point calibration the phase in this point is measured and extrapolated over the measuring range.



Enter O2 opt calibration mode as described in section 7.1 "Enter Calibration Mode".

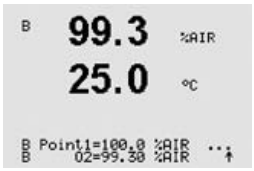


Select 1 point as the calibration type. Press [ENTER].

Place the sensor in the calibration gas (e.g. air) resp. solution.

Depending on the parameterized Drift control (see chapter 8.2.3.5 "Parameters for oxygen measurement based on optical sensors") one of the two following modes is active.

7.5.1.1 Auto mode



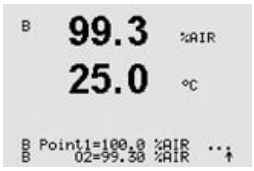
Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter resp. sensor in the units selected by the user.

As soon as the stabilization criteria have been fulfilled the display changes.
The display shows now the values for the phase of the sensor at 100% air (P100) and at 0% (P0) air.

In case of a successful calibration, the calibration values are stored in the cal history and taken over (Adjust), stored in the cal history and not taken over (Calibrate) or discarded (Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.5.1.2 Manual mode



Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter resp. sensor in the units selected by the user.

Press [ENTER] to proceed.

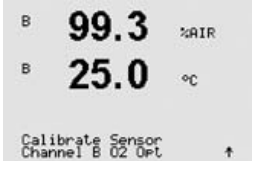
The display shows now the values for the phase of the sensor at 100% air (P100) and at 0% (P0) air.

In case of a successful calibration, the calibration values are stored in the cal history and taken over (Adjust), stored in the cal history and not taken over (Calibrate) or discarded (Abort).

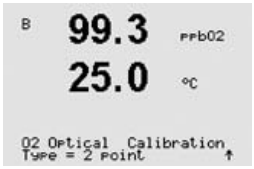
If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.5.2 Two-Point sensor calibration

The calibration of an optical sensor is always a calibration of the phase of the fluorescence signal towards the internal reference. A two-point calibration is a combination of first a calibration in air (100%) where a new phase P100 is measured and then a calibration in nitrogen (0%) where a new phase P0 is measured. This calibration routine gives the most accurate calibration curve over the whole measuring range.



Enter O2 opt calibration mode as described in section 7.1 "Enter Calibration Mode".



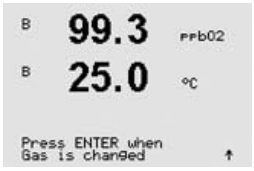
Select 2 point as the calibration type. Press [ENTER].

Place the sensor in air.

Depending on the parameterized Drift control (see chapter 8.2.3.5 "Parameters for oxygen measurement based on optical sensors") one of the two following modes is active.

7.5.2.1 Auto mode

Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter resp. sensor in the units selected by the user.



As soon as the stabilisation criteria have been fulfilled, the display changes and prompts you to change the gas.

Place the senor in the second calibration gas and press the [ENTER] key to go on with the calibration.

Enter the value for Point 2 including a decimal point and units. The value in the second text line is the value being measured by the transmitter resp. sensor.

As soon as the stabilization criteria have been fulfilled the display changes. The display shows now the values for the phase of the sensor at 100% air (P100) and at 0% (P0) air.

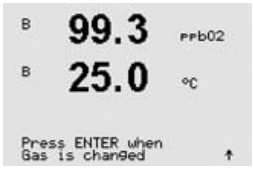
In case of a successful calibration, the calibration values are stored in the cal history and taken over (Adjust), stored in the cal history and not taken over (Calibrate) or discarded (Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.5.2.2 Manual mode

Enter the value for Point 1 including a decimal point and units. The value in the second text line is the value being measured by the transmitter resp. sensor in the units selected by the user.

Press [ENTER] to proceed.



The display changes and prompts you to change the gas.

Place the senor in the second calibration gas and press the [ENTER] key to go on with the calibration.

Enter the value for Point 2 including a decimal point and units. The value in the second text line is the value being measured by the transmitter resp. sensor.

Press [ENTER] to proceed.

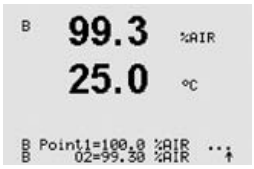
The display shows now the values for the phase of the sensor at 100% air (P100) and at 0% (P0) air.

In case of a successful calibration, the calibration values are stored in the cal history and taken over (Adjust), stored in the cal history and not taken over (Calibrate) or discarded (Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

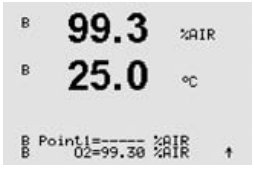
7.5.3 Process calibration

The calibration of an optical sensor is always a calibration of the phase of the fluorescence signal towards the internal reference. During a process calibration the phase in this point is measured and extrapolated over the measuring range.



Enter O2 opt calibration mode as described in section 7.1 "Enter Calibration Mode".

Select 1 point as the calibration type. Press [ENTER].



Take a sample and press the [ENTER] key again to store the current measuring value. To show the ongoing calibration process, A or B (depending on the channel) is blinking in the display.

After determining the O_2 value of the sample press the [CAL] key again to proceed with the calibration.

Enter the O_2 value of the sample then press the [ENTER] key to start calibration.

The display shows now the values for the phase of the sensor at 100% air (P100) and at 0% (P0) air.

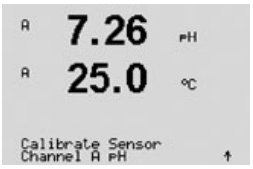
In case of a successful calibration, the calibration values are taken over and stored in the cal history (Adjust), only stored in the cal history (Calibrate) or aborted.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. The M400 returns to the measuring mode.

7.6 pH calibration

For pH sensors, the M400 transmitter features one-point, two-point (Auto or Manual mode) or process calibration with 8 preset buffer sets or manual buffer entry. Buffer values refer to 25 °C. To calibrate the instrument with automatic buffer recognition, you need a standard pH buffer solution that matches one of these values. (See section 8.2.3.2 "pH/ORP parameters" for configuring modes and selecting buffer sets.) Please select the correct buffer table before using automatic calibration (see chapter 19 "Buffer tables").

7.6.1 One point calibration

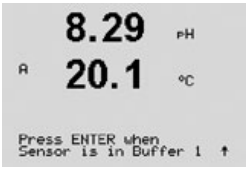


Enter pH calibration mode as described in section 7.1 "Enter Calibration Mode".

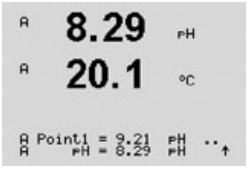
Select 1 point Calibration. With pH sensors a one point calibration is always performed as a offset calibration.

Depending on the parameterized Drift control (see chapter 8.2.3.2 "pH parameters") one of the two following modes is active.

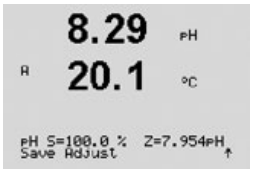
7.6.1.1 Auto mode



Place the electrode in the buffer solution and press the [ENTER] key to start the calibration.



The display shows the buffer the transmitter has recognized (Point 1) and the measured value.



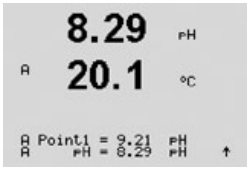
As soon as the stabilisation criteria have been fulfilled the display changes the display shows now the slope calibration factor S and the offset calibration factor Z.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

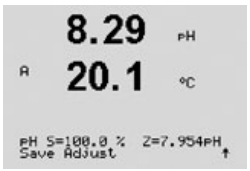
* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.6.1.2 Manual Mode



Place the electrode in the buffer solution. The display shows the buffer the transmitter has recognized (Point 1) and the measured value. Press [ENTER] to proceed.



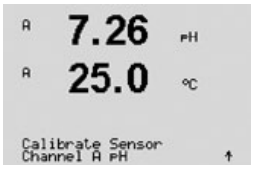
The display shows now the slope calibration factor S and the offset calibration factor Z.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

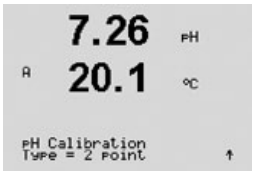
* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.6.2 Two-point calibration



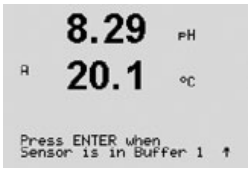
Enter pH calibration mode as described in section 7.1 "Enter Calibration Mode".



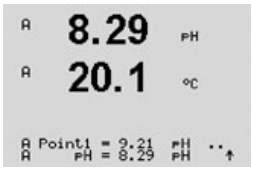
Select 2 Point calibration.

Depending on the parameterized Drift control (see chapter 8.2.3.2 "pH parameters") one of the two following modes is active.

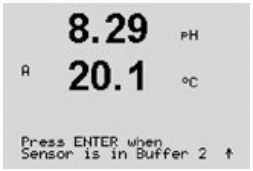
7.6.2.1 Auto Mode



Place the electrode in the first buffer solution and then press the [ENTER] key.

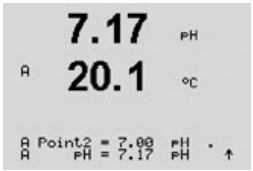


The display shows the buffer the transmitter has recognized (Point 1) and the measured value.



As soon as the stabilisation criteria have been fulfilled stabilisation criteria have been fulfilled, the display changes and prompts you to place the electrode in the second buffer.

Place the electrode in the second buffer solution and press the [ENTER] key to go on with the calibration.



The display shows the second buffer the transmitter has recognized (Point 2) and the measured value.

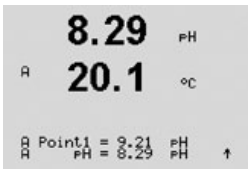
As soon as the stabilisation criteria have been fulfilled the display changes to show the slope calibration factor S and the offset calibration factor Z.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

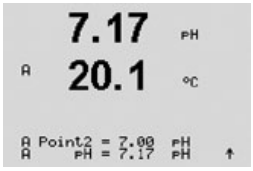
* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

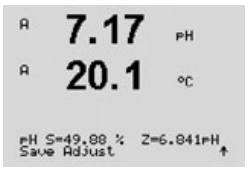
7.6.2.2 Manual Mode



Place the electrode in the first buffer solution. The display shows the buffer the transmitter has recognized (Point 1) and the measured value. Press [ENTER] to proceed.



Place the transmitter in the second buffer solution. The display shows the buffer the transmitter has recognized (Point 2) and the measured value. Press [ENTER] to proceed.

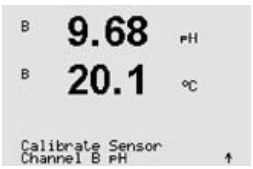


The display shows the slope calibration factor S and the offset calibration factor Z.

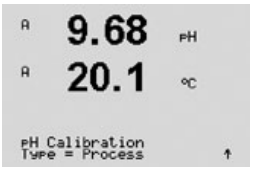
In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

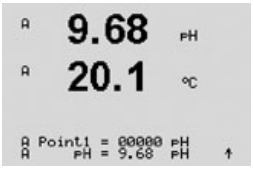
7.6.3 Process calibration



Enter pH calibration mode as described in section 7.1 "Enter Calibration Mode".

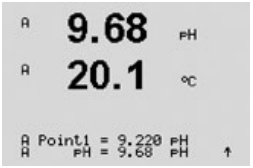


Select Process calibration. With pH sensors a process calibration is always performed as a offset calibration.



Take a sample and press the [ENTER] key again to store the current measuring Value. To show the ongoing calibration process, A or B (depending on the channel) is blinking in the display.

After determining the pH value of the sample, press the [CAL] key again to proceed with the calibration.



Enter the pH value of the sample then press the [ENTER] key to start the calculation of the calibration results.

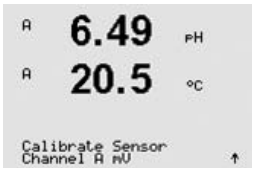
After the calibration the slope calibration factor S and the offset calibration factor Z are displayed.

In case of a successful calibration, the calibration values are stored in the cal history* and taken over (Adjust), stored in the cal history* and not taken over (Calibrate) or discarded (Abort).

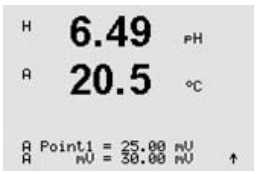
* only available with ISM sensor. The values will be stored in the sensor.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. The M400 returns to the measuring mode.

7.6.4 mV calibration (only for analog sensors)



Enter mV calibration mode as described in section 7.1 "Enter Calibration Mode".



The user can now enter Point 1. The offset calibration factor is calculated by using the value of Point1 instead of the measured value (line 4, mV = ….) and displayed on the next screen.

Z is the newly calculated offset calibration factor. The slope calibration factor S is always 1 and does not enter the calculation.

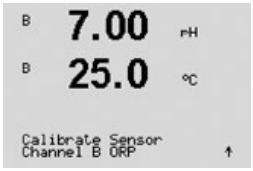
After a successful calibration, the calibration values are taken over (Adjust) or discarded (Calibrate) or (Abort).

If "Adjust" is chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

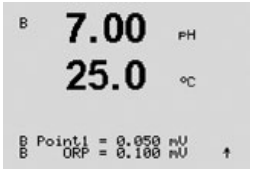
7.6.5 ORP calibration (only for ISM sensors)

In case that an pH sensor with solution ground based on ISM technology is connected to the M400, the transmitter gives the option to make in addition to the pH calibration an ORP calibration.

NOTE: In case of choosing ORP calibration the parameters defined for pH (see chapter 8.2.3.2 "pH/ORP parameters", PATH: Menu/Configure/Measurement/pH) will not be considered.

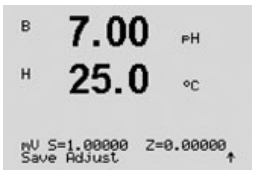


Enter ORP calibration mode as described in section 7.1 "Enter Calibration Mode".



The user can now enter Point 1. In addition the actual ORP is displayed.

Press [ENTER] to proceed.



The display shows the slope calibration factor S and the offset calibration factor Z.

After a successful calibration, the calibration values are taken over and stored in the cal history (Adjust), only stored in the cal history (Calibrate) or aborted.

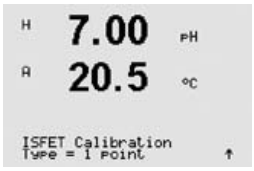
If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.7 ISFET calibration

NOTE: When measuring with an ISFET sensor, the nominal zero point must be adjusted each time a new sensor is connected (to adjust the operating point). The adjustment for that sensor remains stored in the transmitter. Immerse sensor in a zero point buffer (6.5 ... 7.5). Make a mV calibration and enter for point 1 the value 00.00 mV. (see chapter 7.7.4 "mV calibration"). Afterwards a two-point calibration (see chapter 7.7.2 "Two-point calibration") of the ISFET sensor is recommended to achieve best measuring results.

7.7.1 One-point calibration

Enter ISFET calibration mode as described in section 7.1 "Enter Calibration Mode".



Select 1 point Calibration. With ISFET sensors a one point calibration is always performed as a offset calibraton.

The following calibration steps are the same as described for pH sensors (see chapter 7.6.1 "One point calibration").

7.7.2 Two-point calibration

Enter ISFET calibration mode as described in section 7.1 "Enter Calibration Mode".

Select 2 point Calibration.

The following calibration steps are the same as described for pH sensors (see chapter 7.6.2 "Two-point calibration").

7.7.3 Process calibration

Enter ISFET calibration mode as described in section 7.1 "Enter Calibration Mode".

Select Process Calibration. With ISFET sensors a process calibration is always performed as a offset calibration.

The following calibration steps are the same as described for pH sensors (see chapter 7.6.3 "Process calibration").

7.7.4 mV calibration

Enter mV calibration mode as described in section 7.1 "Enter Calibration Mode".

The following calibration steps are the same as described for pH sensors (see chapter 7.6.4 "mV calibration").

7.8 Dissolved carbon dioxide calibration

For dissolved carbon dioxide (CO_2) sensors, the M400 transmitter features one-point, two-point or process calibration. For the one-point or two-point calibration the solution with pH = 7.00 and/or pH = 9.21 of the Mettler – 9 standard buffer has to be used (see also chapter 8.2.3.85 "Dissolved carbon dioxide parameters").

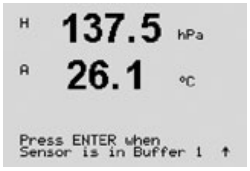
7.8.1 One point calibration

Enter CO_2 calibration mode as described in section 7.1 "Enter Calibration Mode".

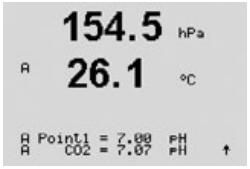
Select 1 point Calibration. With CO2 sensors a one point calibration is always performed as a offset calibration.

Depending on the parameterized Drift control (see chapter 8.2.3.5 "Dissolved carbon dioxide parameters") one of the two following modes is active.

7.8.1.1 Auto Mode



Place the electrode in the buffer solution and press the [ENTER] key to start the calibration.



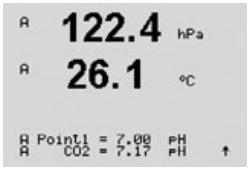
The display shows the buffer the transmitter has recognized (Point 1) and the measured value.

As soon as the stabilisation criteria have been fulfilled the display changes to show the slope calibration factor S and the offset calibration factor Z.

After a successful calibration, the calibration values are taken over (Adjust) or were aborted (Calibrate or Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.8.1.2 Manual Mode



Place the electrode in the buffer solution. The display shows the buffer the transmitter has recognized (Point 1) and the measured value. Press [ENTER] to proceed.

The display shows now the slope calibration factor S and the offset calibration factor Z.

After a successful calibration, the calibration values are taken over (Adjust) or were aborted (Calibrate or Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

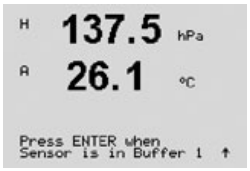
7.8.2 Two-point calibration

Enter CO_2 calibration mode as described in section 7.1 "Enter Calibration Mode".

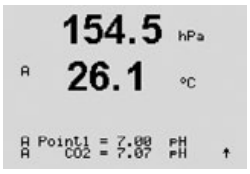
Select 2 Point calibration.

Depending on the parameterized Drift control (see chapter 8.2.3.5 "Dissolved carbon dioxide parameters") one of the two following modes is active.

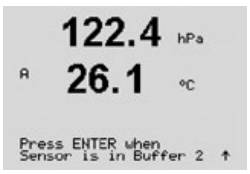
7.8.2.1 Auto Mode



Place the electrode in the first buffer solution and press the [ENTER] key to start the calibration.

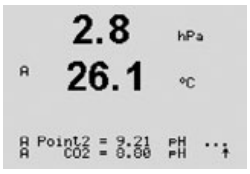


The display shows the buffer the transmitter has recognized (Point 1) and the measured value.

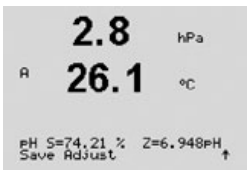


As soon as the stabilisation criteria have been fulfilled, the display changes and prompts you to place the electrode in the second buffer.

Place the electrode in the second buffer solution and press the [ENTER] key to go on with the calibration.



The display shows the second buffer the transmitter has recognized (Point 2) and the measured value.

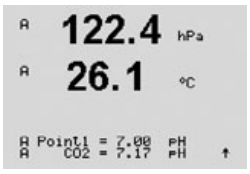


As soon as the stabilisation criteria have been fulfilled, the display changes to show the slope calibration factor S and the offset calibration factor Z.

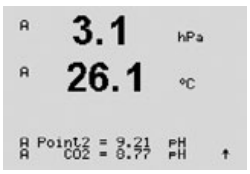
After a successful calibration, the calibration values are taken over (Adjust) or were aborted (Calibrate or Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.8.2.2 Manual Mode



Place the electrode in the first buffer solution. The display shows the buffer the transmitter has recognized (Point 1) and the measured value. Press [ENTER] to proceed.



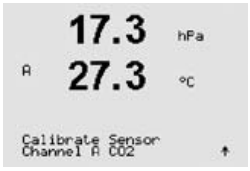
Place the electrode in the second buffer solution. The display shows the buffer the transmitter has recognized (Point 2) and the measured value. Press [ENTER] to proceed.

The display shows the slope calibration factor S and the offset calibration factor Z.

After a successful calibration, the calibration values are taken over (Adjust) or were aborted (Calibrate or Abort).

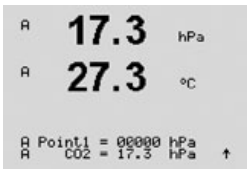
If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.8.3 Process calibration

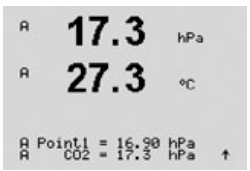


Enter CO_2 calibration mode as described in section 7.1 "Enter Calibration Mode".

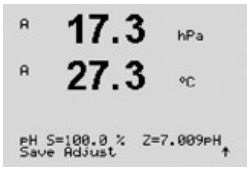
Select Process calibration. With CO2 sensors a process calibration is always performed as a offset calibration.



Take a sample and press the [ENTER] key again to store the current measuring value. To show the ongoing calibration process, A or B (depending on the channel) is blinking in the display. After determining the CO_2 value of the sample, press the ▶ key again to proceed with the calibration.



Enter the CO_2 value of the sample then press the [ENTER] key to start calibration.



The display shows the slope calibration factor S and the offset calibration factor Z.

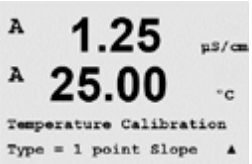
After a successful calibration, the calibration values are taken over (Adjust) or were aborted (Calibrate or Abort).

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. The M400 returns to the measuring mode.

7.9 Sensor temperature calibration (only for analog sensors)

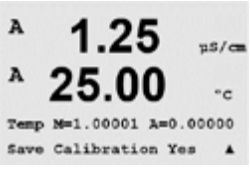
Enter Sensor calibration mode as described in section 7.1 "Enter Calibration Mode" and select Temperature.

7.9.1 One-Point sensor temperature calibration



Select 1 point calibration. Slope or Offset can be selected with the 1 Point calibration. Select Slope to recalculate the Slope factor M (Multiplier) or Offset to recalculate the offset calibration factor A (Adder).

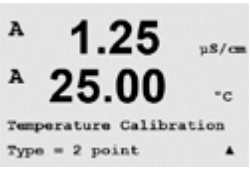
Enter the value for Point 1 and press [ENTER].



After a successful calibration, the calibration values are taken over and stored in the cal history (Adjust), only stored in the cal history (Calibrate) or aborted.

If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

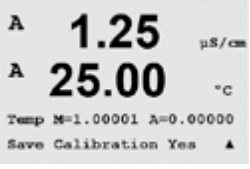
7.9.2 Two-Point sensor temperature calibration



Select 2 Point as calibration type.

Enter the value for Point 1 and press [ENTER].

Enter the value for Point 2 and press [ENTER].



After a successful calibration, the calibration values are taken over and stored in the cal history (Adjust), only stored in the cal history (Calibrate) or aborted.

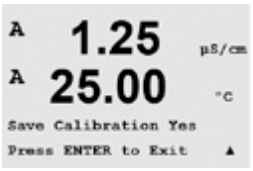
If "Adjust" or "Calibrate" are chosen, the message "Calibration successful" is displayed. In any case you will get the message "Re-install sensor" and "Press ENTER" on the display. After pressing "ENTER" the M400 returns to the measuring mode.

7.10 Edit sensor calibration constants (only for analog sensor)

Enter Calibration mode as described in section 7.1 "Enter Calibration Mode" and select Edit, Edit pH, Edit ISFET, or Edit mV.

All calibration constants for the selected sensor channel are displayed. Primary measurement constants (p) are displayed on Line 3. Secondary measurement (temperature) constants (s) for the sensor are displayed on Line 4.

The calibration constants can be changed in this menu.



Select Yes to save the new calibration values and the successful calibration is confirmed on the display.

NOTE: Each time a new analog conductivity sensor is connected to the M400 Type 1, 2, 3 transmitter, it is necessary to enter the unique calibration data (cell constant and offset) located on the sensor label.

7.11 Sensor verification

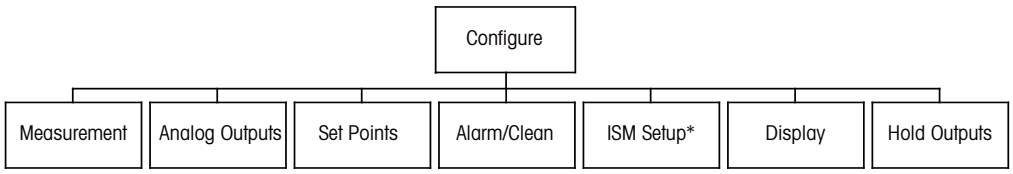
Enter Calibration mode as described in section 7.1. "Enter Calibration Mode" and select Verify.

The measured signal of the primary and the secondary measurement in electrical units are shown. The meter calibration factors are used when calculating these values.

Press [ENTER] to exit from this display.

8 Configuration

(PATH: Menu/Configure)



* Only available in combination with ISM sensors

8.1 Enter configuration mode

While in Measurement mode, press the ◀ key. Press the ▲ or ▼ key to navigate to the Configure – menu and press [ENTER].

8.2 Measurement

(PATH: Menu/Configure/Measurement)

Enter configuration mode as described in Section 8.1 "Enter configuration mode".

Press the [ENTER] key to select this menu. The following sub menus can now be selected: Channel Setup, Temperature Source, Comp/pH/O_2 and Set Averaging.

8.2.1 Channel Setup

(PATH: Menu/Configure/Measurement/Channel Setup)

Press the [ENTER] key to select the "Channel Setup" menu.

Depending on the connected sensor (analog or ISM) the channel can be chosen.

8.2.1.1 Analog sensor

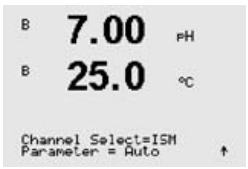
Select sensor type Analog and press [ENTER].

Available measurement types are (depends on transmitter type):

Measurement parameter		Type
pH/ORP	= pH or ORP	1,2,3
ISFET	= pH measurement based on ISFET technology	1,2,3
Cond (2)	= 2 electrode conductivity	1,2,3
Cond (4)	= 4 electrode conductivity	1,2,3
Cond Ind	= Inductive conductivity	1 Cond Ind
O_2 hi	= Dissolved oxygen or oxygen in gas (ppm)	2,3
O_2 lo	= Dissolved oxygen or oxygen in gas (ppb)	3
CO_2	= Accurate CO_2 measurement	3

The 4 lines of the display can now be configured with sensor channel "A" for each line of the display as well as measurements and unit multipliers. Pressing the [ENTER] key will display the selection for lines a, b, c and d.

8.2.1.2 ISM sensor

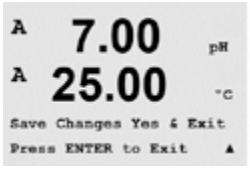


Select sensor type ISM and press [ENTER].

If an ISM sensor is connected, the transmitter automatically (Parameter = Auto) recognizes the type of sensor. You can also fix the transmitter to a certain measurement parameter (Parameter = pH/ORP, Cond(4), O_2 hi or O_2 lo), depending on the type of transmitter you have. Choose the display setting for line a, b, c, d.

Measurement parameter		Type
pH/ORP	= pH and ORP	1, 1 Cond Ind, 2, 3
Cond (4)	= 4 electrode conductivity	1, 1 Cond Ind, 2, 3
O_2 hi	= Dissolved oxygen or oxygen in gas (ppm)	2, 3
O_2 lo	= Dissolved oxygen or oxygen in gas (ppb)	3
O_2 Opt	= Dissolved oxygen optical	2, 3

8.2.1.3 Save changes of the channel setup



After the procedure of the channel setup described in the previous chapter pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.2 Temperature source (only for analog sensors)

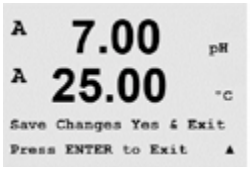
(PATH: Menu/Configure/Measurement/Temperature Source)

Enter Measurement as described in chapter 8.2 "Measurement". Select Temperature Source by using the ▲ or ▼ key and press [ENTER].

The following options can be chosen:

Auto:	The transmitter automatically recognizes the temperature source.
Use NTC22K:	Input will be taken from the sensor attached.
Use Pt1000:	Temperature input will be taken from the sensor attached.
Use Pt100:	Input will be taken from the sensor attached.
Fixed = 25 °C:	Allows a specific temperature value to be entered. It must be chosen when customer use pH sensor without temperature source.

Pressing the [ENTER] key will bring up the Save Changes dialog.



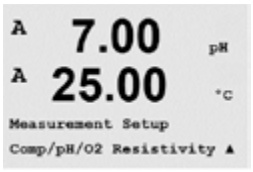
Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.3 Parameter related settings

(PATH: Menu/Configure/Measurement/pH or ISFET or O2 or O2 optical, O2 opt sampling rate, LED Mode or Resistivity or CO2)

Additional measurement and calibration parameters can be set for each parameter; conductivity, pH, ISFET, O_2, and CO2

Enter Configuration Mode as described in section 8.1 "Enter Configuration mode" and select the menu Measurement (see section 8.2 "Configuration/Measurement").



Depending on the connected sensor, the menu pH, ISFET, O2, O2 optical, O2 opt sampling rate, LED Mode, Resistivity or CO2 can be selected by using the ▲ or ▼ key. Press [ENTER]

For more details, please see the following explanations depending on the selected parameter.

8.2.3.1 Conductivity temperature compensation

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter conductivity has been chosen, the temperature compensation mode can be selected. Temperature compensation should be matched to the characteristics of the application. The transmitter considers this value for the temperature compensation by calculating and displaying the result for the measured conductivity.

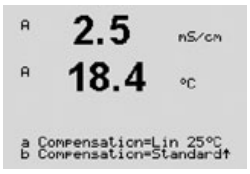
☞ **NOTE:** For calibration purposes the temperature compensation as defined at the menu "Cal/Compensation" for the buffers resp. samples will be considered (see also chapter 7.2 "Conductivity Calibration for two- or four-electrode sensors" resp. chapter 7.3 "Conductivity calibration for inductive sensors").

For doing this adjustment the menu "Resistivity", that will be displayed, has to be chosen. (see chapter 8.2.3 "Parameter related settings")

The first two measurement lines are displayed on the screen. This chapter described the procedure for the first measurement line. By using the key ▶ the second line will be chosen.
To select the 3rd and 4th line press [ENTER]. The procedure itself works at every measurement line in the same way.

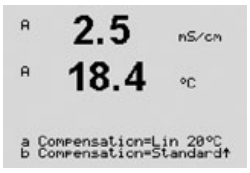
Choices are "Standard", "Lin 25°C" and "Lin 20°C".

Standard compensation includes compensation for non-linear high purity effects as well as conventional neutral salt impurities and conforms to ASTM standards D1125 and D5391.



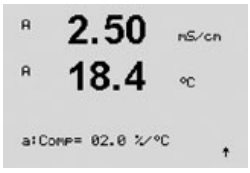
Lin 25 °C compensation adjusts the reading by a factor expressed as a "% per °C" (deviation from 25 °C). Use only if the solution has a well-characterized linear temperature coefficient.

The factory default setting is 2.0% / °C.



Lin 20 °C compensation adjusts the reading by a factor expressed as a "% per °C" (deviation from 20 °C). Use only if the solution has a well-characterized linear temperature coefficient.

The factory default setting is 2.0% / °C



If compensation mode "Lin 25 °C" or "Lin 20 °C" has been chosen, the factor for the adjustment of the reading can be modified after pressing [ENTER] (If working at measurement line 1 or 2 press [ENTER] twice).

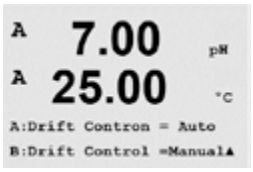
Adjust the factor for temperature compensation.

Pressing [ENTER] will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

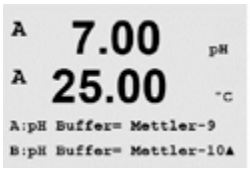
8.2.3.2 pH/ORP parameters

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter pH/ORP has been chosen or an pH sensor based on ISM technology is connected to the transmitter, the parameters drift control, buffer recognition, STC, IP, fixed Calibration temperature and the displayed units for slope and zero point can be set resp. adjusted.

For doing this adjustments resp. settings the menu "pH", that will be displayed, has to be chosen. (see chapter 8.2.3 "Parameter related settings").



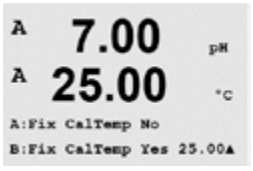
Select the **drift control** for calibration as Auto (drift and time criteria have to be fulfilled) or manual (The user can decide when a signal is stable enough to complete calibration) followed by the relevant buffer table for the automatic buffer recognition. If the drift rate is less than 0.4 mV over a 19 second interval then the reading is stable and the calibration is done using the last reading. If the drift criteria is not met within 300 seconds then the calibration times out and the message "Calibration Not Done" Press ENTER Enter to "Exit" is displayed.
Press [ENTER]



For automatic **buffer recognition** during calibration, select the buffer solution set that will be used: Mettler-9, Mettler-10, NIST Tech, NIST Std = JIS Std, HACH, CIBA, MERCK, WTW or None. See Section 19 "Buffer tables" for buffer values. If the auto buffer feature will not be used or if the available buffers are different from those above, select None. Press [ENTER].

STC is the solution temperature coefficient in units of pH/°C referenced to 25 °C (Default = 0.000 for most applications). For pure waters, a setting of 0.016 pH/°C should be used. For low conductivity power plant samples near 9 pH, a setting of 0.033 pH/°C should be used. These positive coefficients compensate for the negative temperature influence on the pH of these samples. Press [ENTER].

IP is the isothermal point value (Default = 7.000 for most applications). For specific compensation requirements or non standard inner buffer value, this value can be changed. Press [ENTER].



The option to enter a **fixed calibration temperature** is given. "Fixed" allows a specific temperature value to be entered. Selecting "No" means the temperature configured under 8.2.2 will be used for the calibration. Press [ENTER].

The units for the slope and the zero point, that will be shown on the display can be chosen. The default setting for the unit of the slope is [%] and can be changed to [pH/mV]. For the zero point the default setting of the unit is [pH] and can be changed to [mV]. Use the ▶ key to move to the input field and select the unit by using the ▲ or ▼ key.

Pressing [ENTER] again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.3.3 ISFET parameters

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter ISFET has been chosen, the parameters drift control, buffer recognition, STC, IP, fixed Calibration temperature and the displayed units for slope and zero point can be set resp. adjusted.

In case, that an ISFET sensor has been parameterized, the menu "ISFET" will be displayed and has to be chosen. (see chapter 8.2.3 "Parameter related settings")

In the same way as described for pH parameters (see chapter 8.2.3.2 "pH/ORP parameters") parameters for ISFET sensors can be modified.

8.2.3.4 Parameters for oxygen measurement based on amperometric sensors

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter O2 hi or O2 lo has been chosen or an oxygen sensor based on ISM technology is connected to the transmitter, the parameters calibration pressure, process pressure, ProCalPres, salinity and relative humidity can be set resp. adjusted. If an ISM sensor is connected, there is furthermore the option to adjust the parameterization voltage.

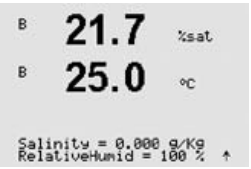
For doing this adjustments resp. settings the menu "O2", that will be displayed, has to be chosen. (see chapter 8.2.3 "Parameter related settings")

Enter the Calibration pressure in line 3. The default value for CalPres is 759.8 and the default unit is mmHg.

To enter the process pressure navigate to line 4. The units for process pressure and calibration pressure do not have to be the same.

Press [ENTER]

For the algorithm of the process calibration the applied pressure (ProcCalPres) has to be defined. The value of the process pressure (ProcPres) or the calibration pressure (CalPres) can be used. Chose the pressure, that applies during the process calibration, resp. should be used for the algorithm and press [ENTER]



In the next step the salinity of the measured solution can be modified.

In addition the relative humidity of the calibration gas can also be entered. The allowed values for relative humidity are in the range 0% to 100%. When no humidity measurement is available, use 50% (default value).

Press [ENTER]

If an ISM sensor has been connected resp. configured there is furthermore the option to adjust the polarization voltage for the sensor. Different value can be entered for the measuring mode (Umeaspol) and for the calibration mode (Ucalpol). For entered values 0 mV to –550 mV the connected sensor will be set to a polarization voltage of –500mV. If the entered value is less then –550mV, the connected sensor will set to a polarization voltage of –674mV.

NOTE: During a process calibration, the polarization voltage Umeaspol, defined for the measuring mode, will be used.

NOTE: If a one point calibration is executed, the transmitter sends the polarization voltage, valid for the calibration, to the sensor. If the polarization voltage for the measuring mode and calibration mode is different, the transmitter will wait 120 seconds before starting the calibration. In this case the transmitter will also go after the calibration for 120 seconds to the HOLD Mode, before returning to the measuring mode again.

Press [ENTER]

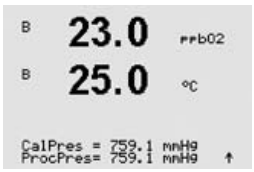
The display shows the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.3.5 Parameters for oxygen measurement based on optical sensors

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter O2 Opt has been chosen, the parameters calibration pressure, process pressure, ProCalPres, salinity, drift control and relative humidity can be set resp. adjusted.

For doing these adjustments the menu "O2 optical", that will be displayed, has to be chosen. (see chapter 8.2.3 "Parameter related settings")

Press [ENTER]

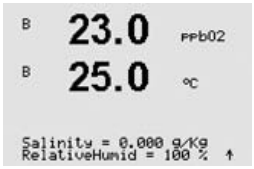


Enter the calibration pressure (line 3). The default value for CalPres is 759.8 and the default unit is mmHg. Also the process pressure (line 4) can be modified. The units for process pressure and calibration pressure do not have to be the same.

For the algorithm of the process calibration the applied pressure (ProcCalPres) has to be defined. The value of the process pressure (ProcPres) or the calibration pressure (CalPres) can be used. Chose the pressure, that applies during the process calibration, resp. should be used for the algorithm.

Select the drift control for calibration as Auto (drift and time criteria have to be fulfilled) or manual (The user can decide when a signal is stable enough to complete calibration). If Auto is selected, the drift is checked by the sensor. If the drift criteria is not met within a defined time (depending on the sensor model) the calibration times out and the message "Calibration Not Done" Press ENTER Enter to "Exit" is displayed.

Press [ENTER]



In the next step the salinity of the measured solution can be modified.

In addition the relative humidity of the calibration gas can also be entered. The allowed values for relative humidity are in the range 0% to 100%. When no humidity measurement is available, use 50% (default value).

Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.3.6 Adjusting sampling rate for optical sensors

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter O2 Opt has been chosen the parameter O2 opt sampling rate can be adjusted.

For doing this adjustment the menu "O2 opt sampling rate" has to be chosen. (see chapter 8.2.3 "Parameter related settings"

The time interval from one measuring cycle of the sensor to the other can be adjusted i.e. adapted to the application. A higher value will increase the life time of the OptoCap of the sensor.

Pressing the [ENTER] key will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.3.7 LED Mode

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter O2 Opt has been chosen the parameters LED, T off, DI 1 LED control can be set resp. adjusted.

For doing these adjustments the menu "LED Mode" has to be chosen. (see chapter 8.2.3 "Parameter related settings".

The operation mode for the LED of the sensor can be selected. There are the following options.

Off: LED is permanently switched off.
On: LED is permanently switched on.
Auto: The LED is switched on as long as the measured media temperature is smaller then Toff (see next value) or switched off thru the digital input signal (see over next value).

NOTE: If the LED is switched off, no oxygen measurement is performed.

Press [ENTER]

Depending on the measured media temperature the LED of the sensor can be automatically switched off. If the media temperature is higher then Toff, the LED will switched off. The LED will be switched on as soon as the media temperature falls below Toff - 3K. This function give the option to increase the lifetime of the OptoCap by switching off the LED thru SIP or CIP cycles.

NOTE: This function is only active if the operation mode of the LED is set to "Auto".

Press [ENTER]

The operation mode of the sensor LED can also be influenced by the digital input signal DI1 of the transmitter. If the parameter "DI 1 LED control" is set to Yes, the LED is switched off, if DI1 is active. If "DI 1 LED control" is set to No, the signal of DI1 has now influence on the operation mode of the sensor LED.
This function is helpful for remote control of the sensor thru a SPS or DCS.

NOTE: This function is only active if the operation mode of the LED is set to "Auto".

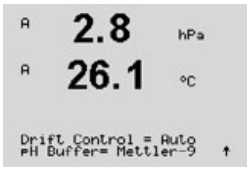
Pressing the [ENTER] key will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.2.3.8 Dissolved carbon dioxide parameters

If during the channel setup (see chapter 8.2.1 "Channel setup") the parameter CO2 has been chosen, the parameters drift control, salinity, HCO3, TotPres and the displayed units for slope and zero point can be set resp. adjusted.

The parameter pH buffer is Mettler-9 and can not be modified. To avoid any interferences of unknown compounds the one-point and two-point calibration can only be done by using Mettler-9 standard buffer. For the calibration please use the solution with pH = 7.00 and/or pH = 9.21.

For doing this adjustment resp. settings the menu "CO2", that will be displayed, has to be chosen. (see chapter 8.2.3 "Parameter related settings")



Select **Drift Control** for calibration as Auto (drift and time criteria have to be fulfilled) or manual (the user can decide when a signal is stable enough to complete calibration) followed by the relevant buffer table for the automatic buffer recognition. If the drift rate is less than 0.4 mV over a 19 second interval then the reading is stable and the calibration is done using the last reading. If the drift criteria is not met within 300 seconds then the calibration times out and the message "Calibration Not Done Press ENTER to Exit" is displayed.

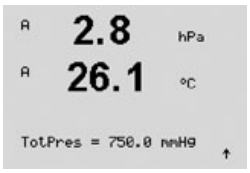
The **pH Buffer** is given by Mettler-9 and can not be modified to avoid any interferences of unknown compounds. For calibration purposes please use the solution with pH = 7.00 and/or pH = 9.21.

Press [ENTER] to go on.

The **Salinity** describes the total amount of solved salts in the CO_2 electrolyte of the sensor connected to the transmitter. It is a sensor specific parameter. The default value (28.00 g/L) is valid for the InPro 5000. Do not change this parameter if the InPro 5000 will be used.

The parameter **HCO_3** describes the concentration of hydrogen carbonate in the CO_2 electrolyte of the sensor connected to the transmitter. It is also a sensor specific parameter. The default value 0.050 Mol/L is valid for the InPro 5000. Do not change this parameter if the InPro 5000 will be used.

To go on press [ENTER] again.



If the unit for the measured dissolved carbon dioxide is %sat, the pressure during the calibration resp. measurement has to be considered. This will be done by setting the parameter TotPres. If another unit then %sat has been selected, the result will not be influenced by this parameter.

Pressing [ENTER] again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

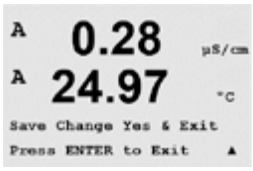
8.2.4 Set averaging

Enter Configuration Mode as described in section 8.1 "Enter Configuration mode" and select the menu Measurement (see section 8.2 "Configuration/Measurement").

Selected the menu "Set Averaging" by using the ▲ or ▼ key. Press [ENTER]

The averaging method (noise filter) for each measurement line can now be selected.
The options are Special (Default), None, Low, Medium and High:

None = no averaging or filtering
Low = equivalent to a 3 point moving average
Medium = equivalent to a 6 point moving average
High = equivalent to a 10 point moving average
Special = averaging depending on signal change (normally High averaging but Low averaging for large changes in input signal)



Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.3 Analog outputs

(PATH: Menu/Configure/Analog Outputs)

Enter Configuration mode as described in Section 8.1. "Enter Configuration Mode" and navigate to the menu "Analog Outputs" by using the ▲ or ▼ key.

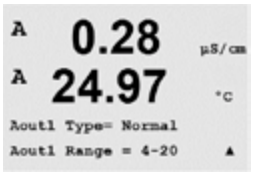
Press the [ENTER] key to select this menu, which lets you configure the 4 analog outputs.

Once analog outputs have been selected, use the ◀ and ▶ buttons to navigate between configurable parameters. Once a parameter is selected, its setting can be selected per the following table:

When an alarm value is selected (see chapter 8.5.1 "Alarm";
PATH: Menu/Configure/Alarm/Clean/Setup Alarm),
the analog output will go to this value if any of these alarm conditions occurs.

Parameter	**Selectable Values**
Aout:	1, 2, 3 or 4 (default is 1)
Measurement:	a, b, c, d or blank (none) (default is blank)
Alarm Value:	3.6 mA, 22.0 mA or Off (default is off)

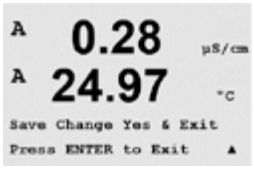
The Aout type can be Normal, Bi-Linear, Auto-Range or Logarithmic. The range can be 4–20 mA or 0–20 mA. Normal provides linear scaling between the minimum and maximum scaling limits and is the default setting. Bi-Linear will also prompt for a scaling value for the mid-point of the signal and allows two different linear segments between the minimum and maximum scaling limits.



Enter the minimum and maximum value of Aout.

If Auto-Range was selected then Aout max1 can be configured. Aout max1 is the maximum value for the first range on auto-range. The maximum value for the second range on auto-range was set in the previous menu. If Logarithmic Range was selected, it will also prompt for the number of decades as "Aout1 # of Decades =2".

The value for the Hold mode can be configured to hold the last value or can be set to a fixed value.



Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.4 Set points

(PATH: Menu/Configure/Set Points)

Enter Configuration mode as described in Section 8.1. "Enter Configuration Mode" and navigate to the menu "Set Points" by using the ▲ or ▼ key.

Press the [ENTER] key to select this menu.

Up to 6 setpoints can be configured on any of the measurements (a thru d). The possible Setpoint types are Off, High, Low, Outside and Between.

An "Outside" setpoint will cause an alarm condition whenever the measurement goes above its high limit or below its low limit. A "Between" setpoint will cause an alarm condition to occur whenever the measurement is between its high and low limits.

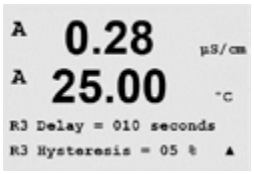
Enter the desired value(s) for the setpoint and press [ENTER]

Depending on the defined setpoint type, this screen provides the option to adjust the values for the setpoint(s).

Press [ENTER] to proceed.

Out of Range
Once configured, the selected relay will be activated if a sensor Out of Range condition is detected on the assigned input channel. Select the setpoint and "Yes" or "No". Select the desired relay that will activate when the setpoint alarm condition is reached.

Press [ENTER]



Delay
Enter the delay time in seconds. A time delay requires the setpoint to be exceeded continuously for the specified length of time before activating the relay. If the condition disappears before the delay period is over, the relay will not be activated.

Hysteresis
Enter the hysteresis as a percentage-value. A hysteresis value requires the measurement to return within the setpoint value by a specified percentage before the relay is deactivated.

For a high setpoint, the measurement must decrease more than the indicated percentage below the setpoint value before the relay is deactivated. With a low setpoint, the measurement must rise at least this percentage above the setpoint value before the relay is deactivated. For example, with a high setpoint of 100, when this value is exceeded, the measurement must fall below 90 before the relay is deactivated.

Press [ENTER]

Hold
Enter the Relay Hold Status of "Last", "On" or "Off". This is the state the relay will go to during a hold status.

State
Relay contacts are in normal state until the associated setpoint is exceeded, then the relay is activated and the contact states change.

Select "Inverted" to reverse the normal operating state of the relay (i.e. normally open contacts are in a closed state, and normally closed contacts are in an open state, until the setpoint is exceeded). "Inverted" relay operation is functional when power is applied to the M400 transmitter. Relay No 2 always operates inverted. All other relays can be configured.

Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.5 Alarm/Clean

(PATH: Menu/Configure/Alarm/Clean)

Enter configuration mode as described in Section 8.1 "Enter Configuration Mode".

This menu allows the configuration of alarm and clean functionality.

8.5.1 Alarm

To select "Setup Alarm", press the ▲ or ▼ key so that "Alarm" is flashing.

Using the ◀ and ▶ buttons, navigate to "Use Relay #". Using the ▲ or ▼ keys, select a relay to be used for the alarm and press [ENTER].

One of the following events may be alarmed:

1. Power failure
2. Software failure
3. Rg diagnostics – pH glass membrane resistance (only for pH and dissolved carbon dioxide sensors)
4. Rr diagnostics – pH reference resistance (only for pH sensors)
5. Cond cell open (only for analogue cond 2-e / 4-e sensors)
6. Cond cell shorted (only for analogue cond 2-e / 4-e sensors)
7. Channel B disconnected (only for ISM sensors)
8. Shaft error (only for optical sensors)
9. Signal error (only for optical sensors)
10. Hardware error (only for optical sensors)
11. Cond Ind Defect (only for inductive conductivity sensors)
12. Dry Cond sensor (only for ISM cond sensors)
13. Cell deviation (only for ISM cond sensors)

If any of these criteria are set to Yes and the conditions for an alarm are given, the flashing symbol ⚠ will be shown in the display, an alarm message will be recorded (see also chapter Messages; PATH: Info/Messages) and the selected relay will be activated. Furthermore an alarm can be indicated by the current output if this has been parameterized (see chapter 8.3 "Analog outputs"; PATH: Menu/Configure/Analog Outputs)

The conditions for alarms are:

1. There is a power failure or power cycling
2. the software watchdog performs a reset
3. Rg is out of tolerance – for example, broken measuring electrode (only for pH and dissolved carbon dioxide sensors)
4. Rr is out of tolerance – for example, coated or depleted reference electrode (only for pH sensors)
5. If the conductivity sensor is on air (for example in an empty pipe) (only for resistive conductivity sensors)
6. If the conductivity sensor has a short cut (only for resistive conductivity sensors)
7. If no sensor is connected on channel B (only for ISM sensors)
8. If the temperature is out of range, stray light is too high (e.g. because a glass fiber is broken) or the shaft has been removed (see also chapter 11.1 "Diagnostics"; PATH: Menu/Service/Diagnostics/O_2 optical) (only for optical sensors)
9. If the signal or the temperature value is out of range (see also chapter 11.1 "Diagnostics"; PATH: Menu/Service/Diagnostics/O_2 optical) (only for optical sensors)
10. If an hardware error has been detected (see also chapter 11.1 "Diagnostics"; PATH: Menu/Service/Diagnostics/O_2 optical). (Only for optical sensors)
11. If the sensors is faulty e. g. through broken wires or a short cut (only for inductive conductivity sensors)
12. If the conductivity sensor is on air (for example in an empty pipe) (only for ISM conductivity sensors)
13. Cell constant (multiplier) is out of tolerance, i.e. has changed too much compared to the value thru the factory calibration (only for ISM conductivity sensors)

For 1 and 2 the alarm indicator will be turned off when the alarm message is cleared. It will reappear if the power is constantly cycling or if the watchdog is repeatedly resetting the system.

Only for pH sensors
For 3 and 4 the alarm indicator will go off if the message is cleared and the sensor has been replaced or repaired so that the Rg and Rr values are within specification. If the Rg or Rr message is cleared and Rg or Rr is still out of tolerance then the alarm will stay on and the message will reappear. The Rg and Rr alarm can be turned off by going into this menu and setting Rg diagnostics and/or Rr diagnostics to No. The message can then be cleared and the alarm indicator will be off even though Rg or Rr is out of tolerance.

Each alarm relay can be configured in either a Normal or Inverted state. In addition, a Delay for the activation can be set. For more information, refer to Section 8.4 "Setpoints".

If power failure is turned on, only inverted state is possible and cannot be changed.

Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

☞ **Note:** There are additional alarms, which will be indicated in the display. See therefore in chapter 17 "Troubleshooting" the different warning- and alarm lists.

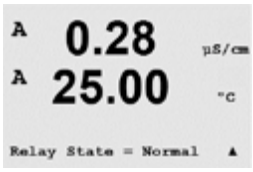
8.5.2 Clean

Configure the relay to be used for the cleaning cycle.

The default value is relay 1.

The cleaning interval can be set from 0.000 to 999.9 hours. Setting it to 0 turns the clean cycle off. The cleaning time can be 0 to 9999 seconds and must be smaller than the cleaning interval.

Select the desired Relay state: Normal or Inverted.



Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.6 ISM set up (available for pH and oxygen ISM sensors)

(PATH: Menu/Configure/ISM Setup)

Enter Configuration mode as described in Section 8.1. "Enter Configuration Mode" and navigate to the menu "ISM set up" by using the ▲ or ▼ key. Press [ENTER]

8.6.1 Sensor monitoring

Select the menu "Sensor Monitoring" by pressing [ENTER].

The sensor monitoring options can be turned on or off and every alarm can be assigned to a certain output relays. The following options are possible:

Lifetime indicator: The dynamic lifetime indication allows an estimation, when the pH electrode or the inner body of an amperometric oxygen sensors or the OptoCap of an optical oxygen sensor is at the end of his lifetime, based on the actual stress he is exposed to. The sensor permanently takes the averaged stress of the past days into consideration and is able to increase/decrease the lifetime accordingly.

Lifetime Indicator		YES/NO	
Alarm	YES/NO	R#	choose relay

The following parameters affect the lifetime indicator:

Dynamic parameters:
– Temperature
– pH or oxygen value
– Glass impedance (only pH)
– Reference impedance (only pH)

Static parameters:
– Calibration history
– Zero and Slope
– Phase 0 and phase 100 (only optical DO)
– Illumination time (only optical DO)
– CIP/SIP/Autoclaving cycles

The sensor keeps the information stored in the built in electronics and can be retrieved via a transmitter or the iSense asset management suite.

The alarm will be reset if the Lifetime Indicator is not 0 days anymore (e.g. after connecting a new sensor or changing on the measurement conditions).

For amperometric oxygen sensors, the lifetime indicator is related to the inner-body of the sensor. After exchanging the inner-body, reset the lifetime indicator as described in chapter 8.6.5 "Reset ISM counter/timer".

For optical DO sensors the lifetime indicator is related to the OptoCap. After exchanging the OptoCap, reset the lifetime indicator as described in chapter 8.6.5 "Reset ISM counter / timer"

If the Lifetime Indicator is turned on, in the measuring mode the value will be automatically shown in the display on line 3.

Press [ENTER]

Time to Maintenance (not for optical sensors): This timer estimates when the next cleaning cycle should be performed to keep the best possible measurement performance. The timer is influenced by significant changes on the DLI parameters.

Time to Maintenance		YES/NO	
Alarm	YES/NO	R#	choose relay

The time to maintenance can be reset to the initial value by the menu "Reset ISM Counter Timer" (see chapter 8.6.5 "Reset ISM counter/timer"). For amperometric oxygen sensors, the time to maintenance indicates a maintenance cycle for the membrane and electrolyte.

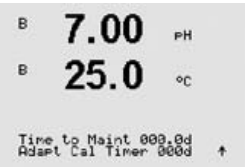
Press [ENTER]

Activation of the Adaptive Cal Timer: This timer estimates when the next calibration should be performed to keep the best possible measurement performance. The timer is influenced by significant changes on the DLI parameters.

Adaptive Cal Timer		YES/NO	
Alarm	YES/NO	R#	choose relay

The Adaptive Calibration Timer will be reset to his initial value after a successful calibration. After a successful calibration will also be the alarm reset. If the Adaptive Cal Timer is turned on, the value will be automatically shown in the display on line 4.

Press [ENTER]



The initial value for Time to Maintenance as well as the Adaptive Calibration Timer can be modified according to the application experience and loaded down to the sensor.

NOTE: By connecting a sensor, the values for Time to Maintenance and/or Adaptive Calibration Timer are read out by the sensor.

Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values and return to the measurement display screen, selecting Yes will save changes made.

8.6.2 CIP Cycle Limit

Navigate to the menu "CIP Cycle Limit" by using the ▲ and ▼ keys and press [ENTER].

The CIP cycle limit counts the number of CIP cycles. If the limit (user defined) is reached, an alarm can be indicated and set to a certain output relays. The following options are possible:

CIP Max 000			
Alarm	YES/NO	R#	choose relay

If the Max setting is on 000, the counter functionality is turned off. The alarm will be reset after exchanging the sensor. For oxygen sensors, the counter can be reset (see chapter 8.6.5 "Reset ISM counter/timer").

CIP characteristics: CIP Cycles will be automatically recognized by the sensor. Since CIP cycles will vary in intensity (duration and temperature) for each application the algorithm of the counter recognizes an increase of the measurement temperature above a certain level (70 °C for CIP). If the temperature does not decrease below (60 °C for CIP) within the next 5 minutes after the first temperature was reached, the counter in question will be incremented by one and also locked for the next two hours. In the case the CIP would last longer than two hours the counter would be incremented by one once more.

Pressing the [ENTER] key will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

NOTE: In case of an optical oxygen sensor, the value for CIP Max will also be written to the sensor. The transmitter M400 uploads the value CIP Max from an optical oxygen sensor after the connection.

8.6.3 SIP Cycle Limit

Navigate to the menu "SIP Cycle Limit" by using the ▲ and ▼ keys and press [ENTER].

The SIP cycle limit counts the number of SIP cycles. If the limit (user defined) is reached, an alarm can be indicated and set to a certain output relays. The following options are possible:

SIP Max 000
Alarm YES/NO R# choose relay

If the Max setting is on 000, the counter functionality is turned off. The alarm will be reset after exchanging the sensor. For oxygen sensors, the counter can be reset (see chapter 8.6.5 "Reset ISM counter/timer").

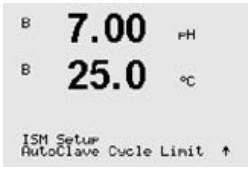
SIP characteristics: SIP Cycles will be automatically recognized by the sensor. Since SIP cycles will vary in intensity (duration and temperature) for each application the algorithm of the counter recognizes an increase of the measurement temperature above a certain level (110 °C for SIP). If the temperature does not decrease below (100 °C for SIP) within the next 5 minutes after the first temperature was reached, the counter in question will be incremented by one and also locked for the next two hours. In the case the SIP would last longer than two hours the counter would be incremented by one once more.

Pressing the [ENTER] key will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

NOTE: In case of an optical oxygen sensor, the value for SIP Max will also be written to the sensor. The transmitter M400 uploads the value SIP Max from an optical oxygen sensor after plugging in.

8.6.4 Autoclaving Cycle Limit

NOTE: The transmitter recognizes the connected ISM sensor and offers this menu only if an autoclavable sensor is connected.



Navigate to the menu "AutoClave Cycle Limit" by using the ▲ and ▼ keys and press [ENTER].

The Autoclaving Cycle Limit counts the number of autoclaving cycles. If the limit (user defined) is reached, an alarm can be indicated and set to a certain output relays. The following options are possible:

Autoclave Max 000
Alarm YES/NO R# choose relay

If the Max setting is on 000, the counter functionality is turned off. The alarm will be reset after exchanging the sensor. For oxygen sensors, the counter can also be reset manually (see chapter 8.6.5 "Reset ISM counter/timer").

Autoclave characteristics: Since during the autoclaving cycle the sensor is not connected to the transmitter, you will be asked after every sensor connection, whether the sensor was autoclaved or not. According to your selection, the counter will be incremented or not.

Pressing the [ENTER] key will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

NOTE: In case of an optical oxygen sensor, the value for AutoClave Max will be written to the sensor. The transmitter M400 uploads the value AutoClave Max from an optical oxygen sensor after plugging in.

8.6.5 Reset ISM counter/timer

This menu allows resetting counter and timer functions which cannot be reseted automatically. The adaptive calibration timer will be reseted after a successful adjustment or calibration.

Navigate to the menu "Reset ISM Counter/Timer" by using the ▲ and ▼ keys and press [ENTER].

If an pH sensor or amperometric oxygen sensor is connected, the menu for resetting the Time To Maintenance is displayed. Time To Maintenance needs to be reset after the following operations.

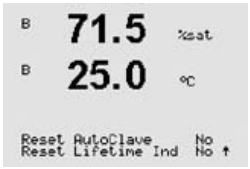
pH sensors: manual maintenance cycle on the sensor.
oxygen sensor: manual maintenance cycle on the sensor or exchanging of the inner-body of the sensor

[Press ENTER]

If an oxygen sensor is connected, the menu for resetting the CIP and SIP counter is displayed. These counters should be reset after the following operations.

opitcal sensor: exchanging of the OptoCap
amperometrical sensor: exchanging of the inner-body of the sensor.

[Press ENTER]



If an oxygen sensor is connected, the menu for resetting the AutoClave Counter and Life Time Indicator is displayed. These parameters should be reset after the following operations.

optical sensor: exchanging of the OptoCap
amperometrical sensor: exchanging of the inner-body of the sensor.

Pressing the [ENTER] key will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make activate entered values.

8.7 Display

(PATH: Menu/Configure/Display)

Enter configuration mode as described in Section 8.1 "Enter Configuration Mode".

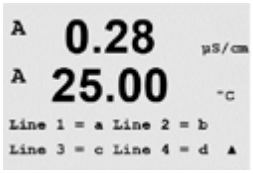
This menu allows for the configuration of the values to be displayed and also the configuration of the display itself.

8.7.1 Measurement

The display has 4 lines. Line 1 on top and Line 4 on the bottom.

Select the values (Measurement a, b, c or d) to be displayed on each line of the display.

The selection of the values for a, b, c, d needs to be done under Configuration/measurement/Channel Setup.



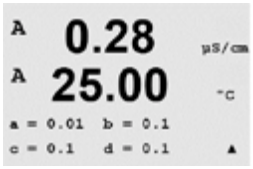
Select the "Error Display" mode. If this is set to "On" when an alarm or warning has occurred, the message "Failure – Press ENTER" will be displayed on Line 4 when an alarm occurs in the normal measurement mode.

Pressing the [ENTER] key again will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

8.7.2 Resolution

This menu allows the setting of the resolution of each displayed value.

The accuracy of the measurement is not effected by this setting.



Possible settings are 1, 0.1, 0.01, 0.001 or Auto.

Pressing the [ENTER] key will bring up the Save Changes dialog.

8.7.3 Backlight

This Menu allows the setting of the back light options of the display.

Possible settings are On, On 50% or Auto Off 50%. If Auto Off 50% is selected then the backlight will go to 50% after 4 minutes with no keypad activity. The backlight will automatically come back on if a key is pressed.

Pressing the [ENTER] key will bring up the Save Changes dialog.

8.7.4 Name

This menu allows for the configuration of an alpha-numeric name which is displayed in the first 9 characters on lines 3 and 4 of the display. The default is nothing (blank).

If a name is entered on line 3 and/or 4 a measurement can be still displayed on the same line.

Use the ◀ and ▶ keys to navigate between digits to be altered. Using the ▲ and ▼ keys to change the character to be displayed. Once all digits of both display channels have been entered, press [ENTER] to bring up the Save Changes dialog.

The resulting display in the measurement mode appears on lines 3 and 4 ahead of the measurements.

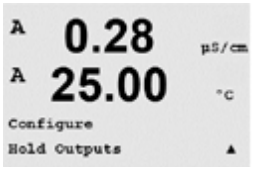
8.7.5 ISM sensor monitoring (available when ISM sensor connected)

The sensor monitoring allows you to display the sensor monitoring details on line 3 and 4 in the display. The following options are possible:

Line 3 Off/Time Indicator/Time to Maint/Adapt Cal Timer
Line 4 Off/Time Indicator/Time to Maint/Adapt Cal Timer

8.8 Hold analog outputs

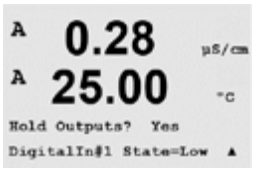
(PATH: Menu/Configure/Hold Outputs)



Enter configuration mode as described in Section 8.1 "Enter Configuration Mode".

The **"Hold outputs"** function applies during the calibration process. If set "Hold outputs" to Yes, during calibration process the analog output, the output relay and USB output will be at hold state. The hold state depends on the setting. For the possible hold settings, see the list below. The following options are possible:

Hold Outputs? Yes/No



The **"DigitalIn"** function applies all the time. As soon as a signal is active on the digital input the transmitter goes to hold mode and the values on the analog output, the output relays and the USB output will be at hold state.

DigitalIn1/2 State = Off/Low/High

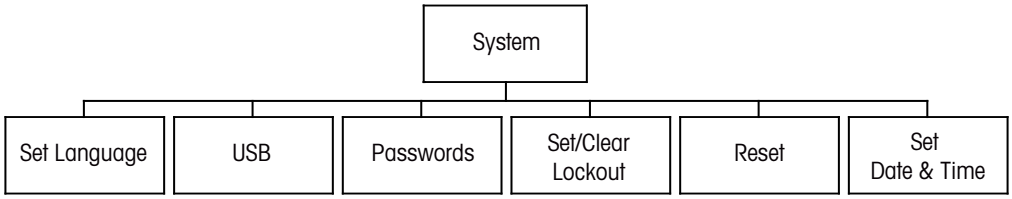
NOTE: DigitalIn1 is to hold channel A (conventional sensor)
DigitalIn2 is to hold channel B (ISM sensor)

Possible Hold states:

Output relays:	On/Off	(Configuration/Set point)
Analog Output:	Last/Fixed	(Configuration/Analog output)
USB:	Last/Off	(System/USB)
PID relay	Last/Off	(PID setup/Mode)
PID analog	Last/Off	(PID setup/Mode)

9 System

(PATH: Menu/System)

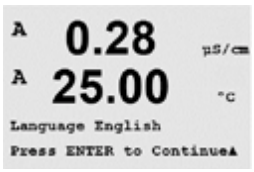


While in measurement mode press the ◀ key. Press the ▼ or ▲ key to navigate to "System" – Menu and press [ENTER].

9.1 Set Language

(PATH: Menu/System/Set Language)

This menu allows the configuration of the display language.



The following selections are possible:
English, French, German, Italian, Spanish, Portuguese, Russian or Japanese (Katakana).

Pressing the [ENTER] key will bring up the Save Changes dialog.

9.2 USB

(PATH: Menu/System/USB)

This menu allows configuration of the USB hold function.

USB hold may be set to either Off or Last Values. An external host device may poll the M400 for data. If the USB hold is set to Off, current values are returned. If the USB hold is set to Last Values, the values present at the time the hold condition was established are returned.

Press [ENTER] to bring up the Save Changes dialog.

9.3 Passwords

(PATH: Menu/System/Passwords)

This menu allows for the configuration of operator and administrator passwords, as well as setting up a list of allowed menus for the operator. The administrator has rights to access all menus. All default passwords for new transmitters are "00000".

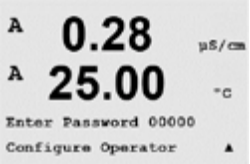
The passwords menu is protected: Enter the administrator password to enter the menu.

9.3.1 Changing passwords

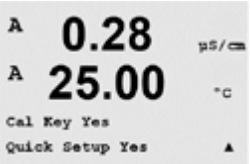
See Section 9.3 on how to enter the passwords menu. Select Change Administrator or Change Operator and set the new password.

Press the [ENTER] key and confirm the new password. Press [ENTER] again to bring up the Save Changed dialog.

9.3.2 Configuring menu access for operator



See 9.3 on how to enter the passwords Menu. Select Configure Operator to configure the access list for the operator. It is possible to assign/deny rights to the following menus: Cal Key, Quick Setup, Configuration, System, PID Setup and Service.

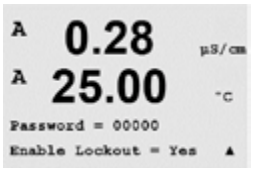


Choose either Yes or No to give/deny access to the above menus and press [ENTER] to advance to the next items. Pressing the [ENTER] key after configuring all menus will bring up the Save Changes dialog. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

9.4 Set/Clear lockout

(PATH: Menu/System/Set/Clear Lockout)

This menu enables/disables the lockout functionality of the transmitter. The user will be asked for a password before being allowed into any menus if the lockout functionality is enabled.



The lockout-menu is protected: Enter the administrator or operator password and select YES to enable or NO to disable the lockout functionality. Pressing the [ENTER] key after the selection will bring up the Save Changes dialog. Selecting No will discard the entered value, selecting Yes will make the entered value the current one.

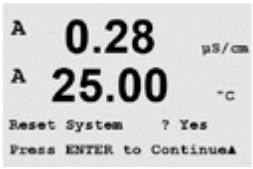
9.5 Reset

(PATH: Menu/System/Reset)

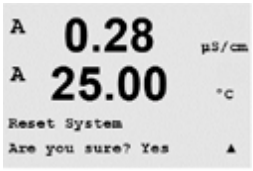
This menu allows access to the following options:

Reset System, Reset Meter Cal, Reset Analog Cal.

9.5.1 Reset system

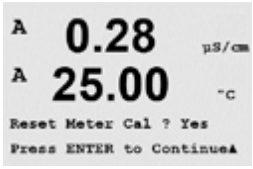


This menu allows the reset of the meter to the factory default settings (setpoints off, analog outputs off, etc.). The meter calibration and the analog output calibration are not affected.

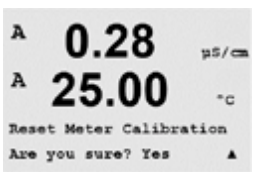


Pressing the [ENTER] key after the selection will bring up a confirmation screen. Selecting No will return the user to the measurement mode with no changes. Selecting Yes will reset the meter.

9.5.2 Reset meter calibration

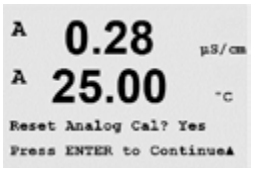


This menu allows the reset of the meter's calibration factors to the last factory calibration values.

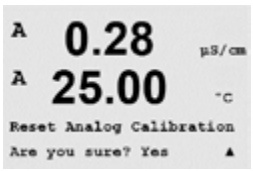


Pressing the [ENTER] key after the selection will bring up a confirmation screen. Selecting No will return the user to the measurement mode with no changes. Selecting Yes will reset the meter calibration factors.

9.5.3 Reset analog calibration



This menu allows reset of the analog output calibration factors to the last factory calibration values.



Pressing the [ENTER] key after the selection will bring up a confirmation screen. Selecting No will return the user to the measurement mode with no changes. Selecting Yes will reset the analog output calibration.

9.5.4 Reset sensor calibration (for optical sensors only)

If an optical oxygen sensor is connected to the transmitter, this menu is available. The menu allows the reset of the calibration data of the sensors to the factory settings.

Pressing the [ENTER] key after the selection will bring up a confirmation screen. Selecting No will return the user to the Measurement mode with no changes. Selecting Yes will reset the calibration data of the sensor to factory settings.

NOTE: Thru a reset of the calibration data the Adaptive Calibration Timer (see chapter 8.6.1 "Sensor monitoring") will set to 0.

NOTE: To ensure best measuring results, a new calibration of the sensor is recommended after a reset of the calibration data to factory settings. Depending on the application resp. sensor, the calibration should be performed as a one point calibration or two point calibration (see chapter 7.5 "Calibration of optical oxygen sensors")

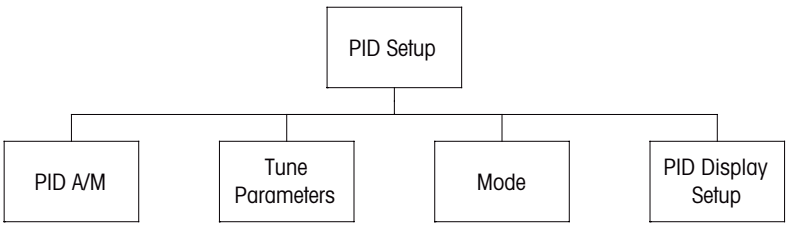
9.6 Set date & time

Please enter the actual date and time. The following options are possible.
This function is automatically activated at every power-up.

Date (YY-MM-DD):
Time (HH:MM:SS):

10 PID setup

(PATH: Menu/PID Setup)



PID control is proportional, integral and derivative control action that can provide smooth regulation of a process. Before configuring the transmitter, the following process characteristics must be identified.

Identify the **control direction** of the process

– **Conductivity:**
  Dilution – direct acting where increasing measurement produces increasing control output such as controlling the feed of low conductivity diluting water to rinse tanks, cooling towers or boilers
  Concentrating – reverse acting where increasing measurement produces decreasing control output, such as controlling chemical feed to attain a desired concentration

– **Dissolved Oxygen:**
  Deaeration – direct acting where increasing DO concentration produces increasing control output such as controlling the feed of a reducing agent to remove oxygen from boiler feedwater
  Aeration – reverse acting where increasing DO concentration produces decreasing control output, such as controlling an aerator blower speed to maintain a desired DO concentration in fermentation or wastewater treatment

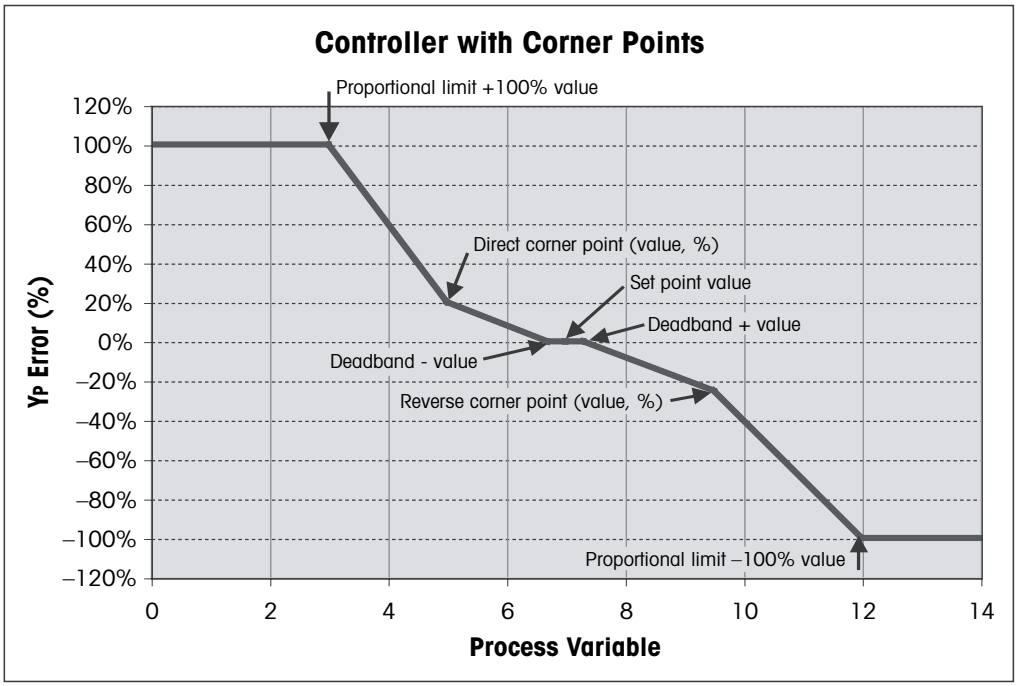
– **pH/ORP:**
  Acid feed only – direct acting where increasing pH produces increasing control output, also for ORP reducing reagent feed
  Base feed only – reverse acting where increasing pH produces decreasing control output, also for ORP oxidizing reagent feed
  Both acid and base feed – direct and reverse acting

Identify the **control output type** based on the control device to be used:
  Pulse frequency – used with pulse input metering pump
  Pulse length – used with solenoid valve
  Analog – used with current input device such as electric drive unit, analog input metering pump or current-to-pneumatic (I/P) converter for pneumatic control valve

Default control settings provide linear control, which is appropriate for conductivity, dissolved oxygen. Therefore, when configuring PID for these parameters (or simple pH control) ignore settings of deadband and corner points in the tuning parameter section below. The non-linear control settings are used for more difficult pH/ORP control situations.

If desired, identify the non-linearity of the pH/ORP process. Improved control can be obtained if the non-linearity is accommodated with an opposing non-linearity in the controller. A titration curve (graph of pH or ORP vs. reagent volume) made on a process sample provides the best information. There is often a very high process gain or sensitivity near the setpoint and decreasing gain further away from the setpoint. To counteract this, the instrument allows for adjustable non-linear control with settings of a deadband around the setpoint, corner points further out and proportional limits at the ends of control as shown in the figure below.

Determine the appropriate settings for each of these control parameters based on the shape of the pH process titration curve.



10.1 Enter PID setup

While in measurement mode press the ◀ key. Press the ▲ or ▼ key to navigate to the PID Set-up-menu and press [ENTER].

10.2 PID auto/manual

(PATH: MENU/PID Setup/PID A/M)

This menu allows selection of automatic or manual operation. Select Auto or Manual operation. Pressing the [ENTER] key will bring up the Save Changes dialog.

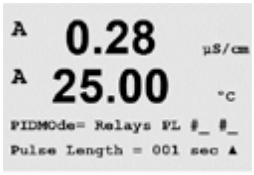
10.3 Mode

(PATH: MENU/PID Setup/Mode)

This menu contains the selection of control modes using relays or analog outputs.

Press [ENTER].

10.3.1 PID mode

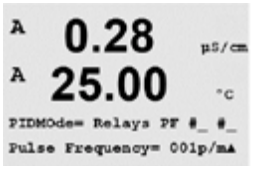


This menu assigns a relay or analog output for PID control action as well as details of their operation. Based on the control device being used, select one of the following three paragraphs for use with solenoid valve, pulse input metering pump or analog control.

Pulse Length – If using a solenoid valve, select "Relays" and "PL", pulse length. Choose the first relay position as #3 (recommended) and/or the second relay position as #4 (recommended) as well as the pulse length (PL) according to the table below. A longer pulse length will reduce wear on the solenoid valve. The % "on" time in the cycle is proportional to the control output.

☞ **NOTE:** All relays from #1 to #6 can be used for the controlling function.

	1st Relay Position (#3)	2nd Relay Position (#4)	Pulse Length (PL)
Conductivity	Controlling concentrating reagent feed	Controlling dilution water	Short (PL) provides more uniform feed. Suggested start point = 30 sec
pH/ORP	Feeding base	Feeding acid	Reagent addition cycle: short PL provides more uniform addition of reagent. Suggested start point = 10 sec
Dissolved Oxygen	Reverse control action	Direct acting control action	Feed cycle time: short PL provides more uniform feed. Suggested start point = 30 sec

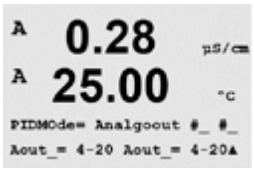


Pulse Frequency – If using a pulse input metering pump, select "Relays" and "PF", pulse frequency. Choose the first relay position as #3 and/or the second relay position as #4 according to the table below. Set the pulse frequency to the maximum frequency allowed for the particular pump being used, typically 60 to 100 pulses/minute. Control action will produce this frequency at 100% output.

NOTE: All relays from #1 to #6 can be used for the controlling function.

CAUTION: Setting the pulse frequency too high may cause the pump to overheat.

	1st Relay Position = #3	2nd Relay Position = #4	Pulse Frequency (PF)
Conductivity	Controlling concentrating chemical feed	Controlling dilution water	Max allowed for the pump used (typically 60–100 pulses/minute)
pH/ORP	Feeding base	Feeding acid	Max allowed for the pump used (typically 60–100 pulses/minute)
Dissolved Oxygen	Reverse control action	Direct acting control action	Max allowed for the pump used (typically 60–100 pulses/minute)



Analog – If using analog control, change "Relays" to "Analogout" using up/down arrow keys. Choose the first Analogout position as #1 and/or the second Analogout position as #2 according to the table below. Select the analog output current range required by the control device, 4–20 or 0–20 mA. Press [ENTER].

	1st Analogout Position = #1	2nd Analogout Position = #2
Conductivity	Controlling concentrating chemical feed	Controlling dilution water
pH/ORP	Feeding base	Feeding acid
Dissolved Oxygen	Reverse control action	Direct acting control action

10.4 Tune parameters

(PATH: MENU/PID Setup/Tune Parameters)

This menu assigns control to a measurement and sets the setpoint, tuning parameters and nonlinear functions of the controller through a series of screens.

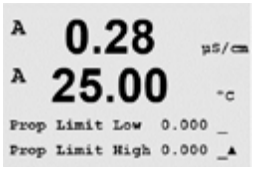
10.4.1 PID assignment & tuning

Assign the measurement, a, b, c, or d to be controlled after "PID on_". Set the Gain (unitless), integral or reset time Tr (minutes) and rate or derivative time Td (minutes) needed for control. Press [ENTER]. Gain, reset and rate are later adjusted by trial and error based on process response. Always begin with Td at zero.

10.4.2 Setpoint & deadband

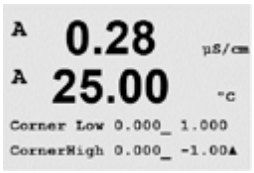
Enter the desired setpoint value and the deadband around the setpoint, where no proportional control action will take place. Be sure to include the units multiplier µ or m for conductivity. Press [ENTER].

10.4.3 Proportional limits



Enter the low and high proportional limits – the range over which control action is required. Be sure to include the units multiplier µ or m for conductivity. Press [ENTER].

10.4.4 Corner points



Enter the low and high corner points in conductivity, pH, dissolved oxygen units and the respective output values from –1 to +1, shown in the figure as –100 to +100%. Press [ENTER].

10.5 PID display

(PATH: Menu/PID Setup/PID Display Setup)

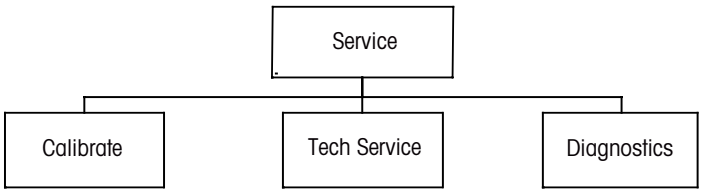
This screen enables display of PID control status in the normal measurement mode.

When PID Display is selected, the status (Man or Auto) and control output (%) will be displayed on the bottom line. If controlling pH, the reagent will also be displayed. In addition, for the display to be enabled, a measurement must be assigned under Tune Parameters and a relay or analog output must be assigned under Mode.

In manual, the control output may be adjusted with the up and down arrow keys. (The "Info" key function is not available in manual.)

11 Service

(PATH: Menu/Service)



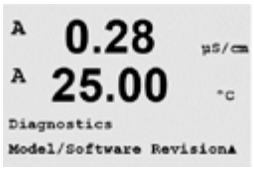
While in measurement mode press the ◀ key. Press the ▲ or ▼ key to navigate to the "Service" menu and press [ENTER]. The available system configuration options are detailed below.

11.1 Diagnostics

(PATH: Menu/Service/Diagnostics)

This menu is a valuable tool for troubleshooting and provides diagnostic functionality for the following items: Model/Software Revision, Digital Input, Display, Keypad, Memory, Set Relays, Read Relays, Set Analog Outputs, Read Analog Outputs.

11.1.1 Model/Software revision



Essential information for every Service call is the model and software revision number.
This menu shows the part number, model and the serial number of the transmitter. By using the ▼ key it is possible to navigate forward through this menu and get additional information like the current version of firmware implemented on the transmitter: (Master V_XXXX and Comm V_XXXX); and – if an ISM sensor is connected – the version of the sensor firmware (FW V_XXX) and sensor hardware (HW XXXX).

Press [ENTER] to exit from this display.

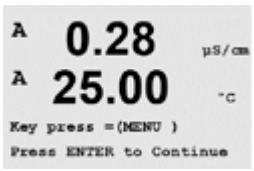
11.1.2 Digital input

The digital input menu shows the state of the digital inputs. Press [ENTER] to exit from this display.

11.1.3 Display

All pixels of the display will be lit for 15 seconds to allow troubleshooting of the display.
After 15 seconds the transmitter will return to the normal measuring mode or press [ENTER] to exit sooner.

11.1.4 Keypad



For keypad diagnostics, the display will indicate which key is pressed. Pressing [ENTER] will return the transmitter to the normal measuring mode.

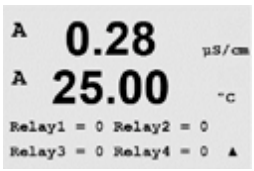
11.1.5 Memory

If Memory is selected then the transmitter will perform a RAM and ROM memory test.
Test patterns will be written to and read from all RAM memory locations. The ROM checksum will be recalculated and compared to the value stored in the ROM.

11.1.6 Set Relay

The Set Relays diagnostic menu allows to open or close each relay manually. To access relays 5 and 6, press [ENTER].

0 = open the relay
1 = close the relay

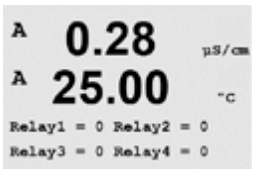


Press [ENTER] to return to Measurement mode.

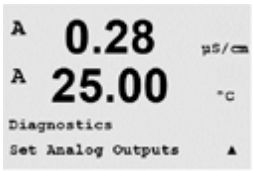
11.1.7 Read relays

The Read Relays diagnostic menu shows the state of each relay as defined below.
To display relays 5 and 6, press [ENTER]. Press [ENTER] again to exit from this display.

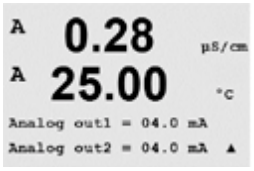
0 = Normal
1 = Inverted.



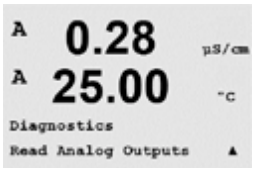
11.1.8 Set analog outputs



This menu enables the user to set all analog outputs to any mA value within the 0–22 mA range. Press [ENTER] to exit from this display.



11.1.9 Read analog outputs



This menu shows the mA value of the analog outputs.

Press [ENTER] to exit from this display.

11.1.10 O_2 Optical

This menu shows the state and conditions regarding the optical O_2 sensor. By using the key ▲ or ▼ it is possible to navigate through this menu and get additional information. Press [ENTER] to exit from this display.

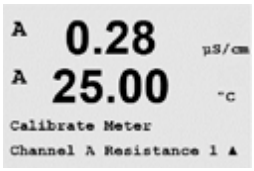
11.2 Calibrate

(PATH: Menu/Service/Calibrate)

Enter Service Menu as described in section 11.1 "Enter Service Menu", select Calibrate, and press [ENTER].

This menu has the options to calibrate the transmitter and the analog outputs and also allows the unlocking of calibration functionality.

11.2.1 Calibrate meter (only for channel A)



The M400 transmitter is factory calibrated within specifications. It is not normally necessary to perform meter re-calibration unless extreme conditions cause an out of spec operation shown by Calibration Verification. Periodic verification/re-calibration may also be necessary to meet Q.A. requirements. Meter calibration can be selected as current (used for most dissolved oxygen, Voltage, Rg Diagnostic, Rr Diagnostic (used for pH), and temperature (used for all measurements).

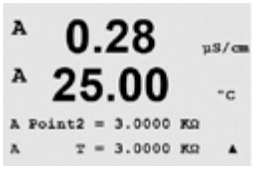
11.2.1.1 Temperature

Temperature is performed as a three point calibration. The table above shows the resistance values of these three points.

Navigate to the Calibrate Meter screen and choose Temperature calibration for Channel A.

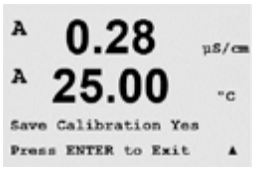
Press [ENTER] to begin temperature calibration process

The first text line will ask for the Point 1 temperature resistance value (this will correspond to temperature 1 value shown on the calibration module accessory). The second text line will show the measured resistance value. When the value stabilizes, press [ENTER] to perform calibration.

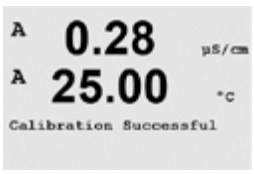


The transmitter screen will then prompt the user to enter the value for Point 2, and T2 will display the measured resistance value. When this value stabilizes, press [ENTER] to calibrate this range.

Repeat these steps for Point 3.



Press [ENTER] to bring up a confirmation screen. Select Yes to save the calibration values and the successful calibration is confirmed on the display.

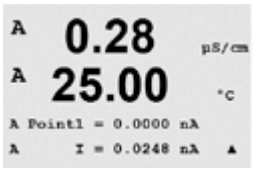


The transmitter will return to the measurement mode in approximately 5 seconds.

11.2.1.2 Current

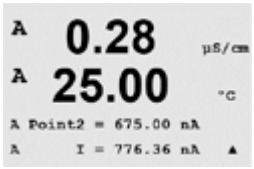
Current calibration is preformed as a two point calibration.

Navigate to the Calibrate Meter screen and select Channel A.

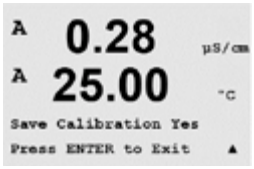


Enter the value for Point 1, in milliamps, of the current source connected to the input. The second display line will show the measured current.

Press [ENTER] to begin the calibration process.

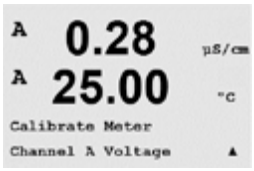


Enter the value for Point 2, in milliamps, of the current source connected to the input. The second display line shows the measured current.



Pressing the [ENTER] key after entering Point 2 will bring up a confirmation screen. Select Yes to save the calibration values and the successful calibration is confirmed on the display. The transmitter will return to the measurement mode in approximately 5 seconds.

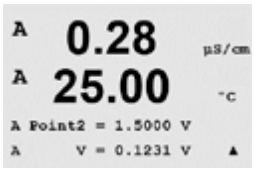
11.2.1.3 Voltage



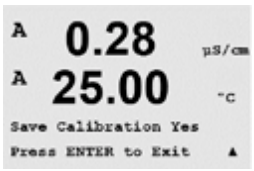
Voltage calibration is preformed as a two point calibration.

Navigate to the Calibrate Meter screen and select Channel A and Voltage.

Enter the value for Point 1 in, volts, connected to the input. The second display line will show the measured voltage. Press[ENTER] to begin the calibration process.

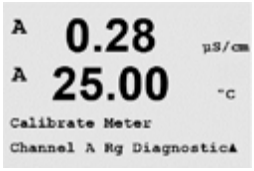


Enter the value for Point 2, in volts, of the source connected to the input.
The second display line shows the measured voltage.

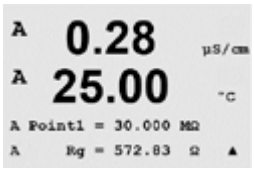


Pressing the [ENTER] key after entering Point 2 will bring up a confirmation screen. Select Yes to save the calibration values and the successful Calibration is confirmed on the display. The transmitter will return to the measurement mode in approximately 5 seconds.

11.2.1.4 Rg diagnostic

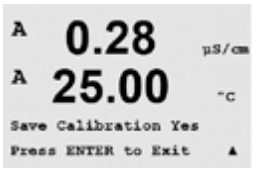


Rg diagnostic is performed as a two point calibration. Navigate to the Calibrate Meter screen and select Channel A and Rg Diagnostic.



Enter the value for Point 1 of the calibration according to the resistor connected across the pH glass electrode measuring input. Press [ENTER] to begin the calibration process.

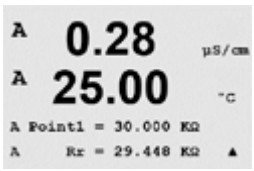
Enter the value for Point 2 of the calibration according to the resistor connected across the pH glass electrode measuring input.



Pressing the [ENTER] key after entering Point 2 will bring up a confirmation screen. Select Yes to save the calibration values and the successful calibration is confirmed on the display. The transmitter will return to the measurement mode in approximately 5 seconds.

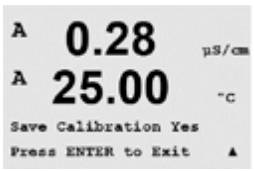
11.2.1.5 Rr diagnostics

Rr diagnostic is performed as a two point calibration. Navigate to the Calibrate Meter screen and select Channel A and Rr Diagnostic.



Enter the value for Point 1 of the calibration according to the resistor connected across the pH reference measuring input. Press [ENTER] to begin the calibration process.

Enter the value for Point 2 of the calibration according to the resistor connected across the pH reference measuring input.

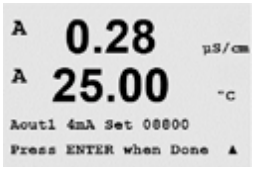


Pressing the [ENTER] key after entering Point 2 will bring up a confirmation screen. Select Yes to save the calibration values and the successful calibration is confirmed on the display. The transmitter will return to the measurement mode in approximately 5 seconds.

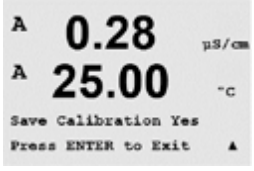
11.2.1.6 Calibrate analog

Select the Analog Output you wish to calibrate. Each analog output can be calibrated at 4 and 20 mA.

Connect an accurate milliamp meter to the analog output terminals and then adjust the five digit number in the display until the milliamp meter reads 4.00 mA and repeat for 20.00 mA.



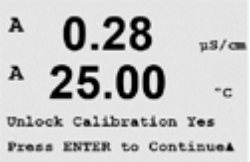
As the five digit number is increased the output current increases and as the number is decreased the output current decreases. Thus coarse changes in the output current can be made by changing the thousands or hundreds digits and fine changes can be made by changing the tens or ones digits.



Pressing the [ENTER] key after entering both values will bring up a confirmation screen. Selecting No will discard the entered values, selecting Yes will make the entered values the current ones.

11.2.2 Calibrate unlock

Select this Menu to configure the CAL Menu, see Section 7.



Selecting Yes means that meter and analog output calibration menus will be selectable under the CAL Menu. Selecting No means that only the sensor calibration is available under the CAL Menu. Press [ENTER] after the selection to display a confirmation screen.

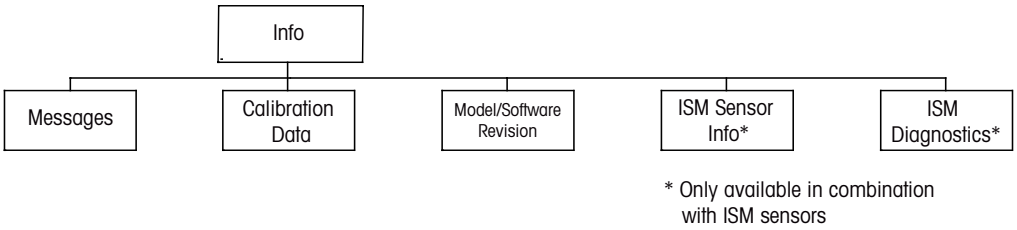
11.3 Tech Service

(PATH: Menu/Tech Service)

Note: This menu is for Mettler Toledo service personnel use only.

12 Info

(PATH: Info)



Pressing the ▼ key will display the Info menu with the options Messages, Calibration Data and Model/Software Revision.

12.1 Messages

(PATH: Info/Messages)

The most recent message is displayed. The up and down arrow keys allow scrolling through the last four messages that have occurred.

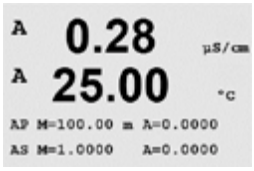
Clear Messages clears all the messages. Messages are added to the message list when the condition that generates the message first occurs. If all messages are cleared and a message condition still exists and started before the clear then it will not appear in the list. For this message to re-occur in the list the condition must go away and then reappear.

Press [ENTER] to exit from this display.

12.2 Calibration data

(PATH: Info/Calibration Data)

Selecting Calibration Data displays the calibration constants for each sensor.

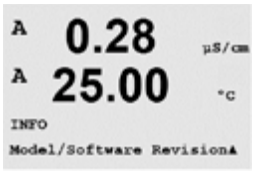


P = calibration constants for the primary measurement
S = calibration constants for the secondary measurement

Press [ENTER] to exit from this display.

12.3 Model/Software revision

(PATH: Info/Model/Software Revision)



Selecting Model/Software Revision will display the part number, model and the serial number of the transmitter.

By using the ▼ key it is possible to navigate forward through this menu and get additional information like the current version of firmware implemented on the transmitter (Master V_XXXX and Comm V_XXXX) and – if an ISM sensor is connected – the version of the sensor firmware (FW V_XXX) and sensor hardware (HW XXXX).

The displayed information is important for any Service call. Press [ENTER] to exit from this display.

12.4 ISM sensor info (available when ISM sensor connected)

(PATH: Info/ISM Sensor Info)

After plugging in an ISM sensor it is possible by using the key ▲ or ▼ to navigate to the Menu "ISM Sensor Info".

Press [ENTER] to select the menu.

The following information about the sensor will be shown in this menu. Use up and down arrows to scroll in the menu. Type: Type of sensor (e.g. InPro 3250)

Cal Date: Date of the last adjustment
Serial-No.: Serial number of the connected sensor
Part-No.: Part number of the connected sensor

Press [ENTER] to exit from this display.

12.5 ISM sensor diagnostics (available when ISM sensor connected)

(PATH: Info/ISM Diagnostics)

After plugging in an ISM sensor it is possible by using the key ▲ or ▼ to navigate to the Menu "ISM Diagnostics".

Press [ENTER] to select the menu.

Navigate to one of the menus, described in this section, and press [ENTER] again.

Cal History
The calibration history is stored with a time stamp in the ISM sensor and is displayed on the transmitter. The calibration history offers the following information:

Fact (Factory calibration): This is the original dataset, determined in the factory. This dataset remains stored in the sensor for reference and cannot be overwritten.

Act (Actual adjustment): This is the actual calibration dataset which is used for the measurement. This dataset moves to Cal-2 position after the next adjustment.

1. Adj (First adjustment): This is the first adjustment after the factory calibration. This dataset remains stored in the sensor for reference and cannot be overwritten

Cal-1 (last calibration/adjustment): This is the last executed calibration/adjustment. This dataset moves to Cal-2 and then to Cal-3 when a new calibration/adjustment is performed. Afterwards, the dataset is not available anymore.

Cal-2 and Cal-3 acting in the same way as Cal-1.

Definition:
Adjustment: The calibration procedure is completed and the calibration values are taken over and used for the measurement (Act) and stated in Cal-1. The current values from Act will move to Cal-2.

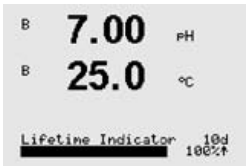
Calibration: The calibration procedure is completed, but the calibration values will not be overtaken and the measurement continuous with the last valid adjustment dataset (Act). The dataset will be stored under Cal-1.

The calibration history is used for the estimation of the lifetime indicator for ISM sensors.

Press [ENTER] to exit from this display.

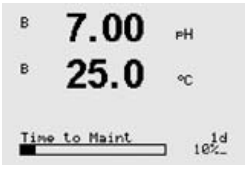
Note: This function requires the correct setting of date and time during calibration and / or adjustment tasks (see chapter 9.6 "Set date & time").

Sensor monitoring (not available for Cond 4-e sensor)
The sensor monitoring shows the different diagnostics functions available for each ISM sensor. The following information is available:



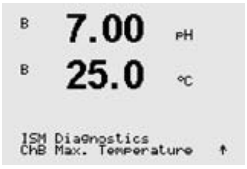
Lifetime Indicator: Shows an estimation of the remaining lifetime to ensure a reliable measurement. The lifetime is indicated in days (d) and percentage (%). For a description of the Lifetime indicator, please see section 8.6 "ISM Setup". For oxygen sensors, the lifetime indicator is related to the inner-body of the sensor or the OptoCap for optical sensors. If you want to bring the bar indicator on the screen, see chapter 8.7.5 "ISM sensor monitoring" to activate ISM functions.

Adaptive Cal Timer: This timer shows a Adaptive Cal Timer, when the next calibration should be performed to keep the best possible measurement performance. The Adaptive Cal Timer is indicated in days (d) and percentage (%). For a description of the Adaptive Cal Timer, please see section 8.6 "ISM Setup".



Time to Maintenance: This timer shows a Time to Maintenance, when the next cleaning cycle should be performed to keep the best possible measurement performance. The Time to Maintenance is indicated in days (d) and percentage (%). For a description of the Time to Maintenance, please see section 8.6 "ISM Setup". For oxygen sensors, the Time to Maintenance indicates a maintenance cycle for the membrane and electrolyte.

Press [ENTER] to exit from this display.



Max. Temperature
The maximum temperature shows the maximum temperature that this sensor has ever seen, together with a time stamp of this maximum. This value is stored on the sensor and cannot be changed. During autoclaving the Max temperature is not recorded.

Max. Temperature
Tmax XXX°C YY/MM/DD

Press [ENTER] to exit from this display.

Note: This function requires the correct setting of date and time of the transmitter.
(see chapter 9.6 "Set date & time")

CIP Cycles
Shows the amount of CIP cycles that the sensor has been exposed to. For a description of the CIP Cycle indicator, please see section 8.6 "ISM Setup"

CIP Cycles xxx of xxx

Press [ENTER] to exit from this display.

SIP Cycles
Shows the amount of SIP cycles that the sensor has been exposed to. For a description of the SIP Cycle indicator, please see section 8.6 "ISM Setup"

SIP Cycles xxx of xxx

Press [ENTER] to exit from this display.

Autoclaving Cycles
Shows the amount of Autoclaving cycles that the sensor has been exposed to. For a description of the AutoClave Cycle indicator, please see section 8.6 "ISM Setup"

Autoclaving Cycles xxx of xxx

Press [ENTER] to exit from this display.

13 Maintenance

13.1 Front panel cleaning

Clean the front panel with a damp soft cloth (water only, no solvents). Gently wipe the surface and dry with a soft cloth.

14 Troubleshooting

If the equipment is used in a manner not specified by Mettler-Toledo Thornton, Inc., the protection provided by the equipment may be impaired.
Review the table below for possible causes of common problems:

Problem	Possible Cause
Display is blank.	– No power to M400. – Blown fuse. – LCD display contrast set incorrectly. – Hardware failure.
Incorrect measurement readings.	– Sensor improperly installed. – Incorrect units multiplier entered. – Temperature compensation incorrectly set or disabled. – Sensor or transmitter needs calibration. – Sensor or patch cord defective or exceeds recommended maximum length. – Hardware failure.
Measurement readings not stable.	– Sensors or cables installed too close to equipment that generates high level of electrical noise. – Recommended cable length exceeded. – Averaging set too low. – Sensor or patch cord defective.
Displayed ⚠ is flashing.	– Setpoint is in alarm condition (setpoint exceeded). – Alarm has been selected (see chapter 8.5.1 ″Alarm″) and occurred.
Cannot change menu settings.	– User locked out for security reasons.

14.1 Changing the fuse

Make sure that the mains cable is unplugged before changing the fuse. This operation should only be carried out by personnel familiar with the transmitter and who are qualified for such work.

If the power consumption of the M400 transmitter is too high or a manipulation leads to a short circuit the fuse will blow. In this case remove the fuse and replace it with one specified in section 15 ″Accessories and Spare Parts″.

14.2 Cond (resistive) Error messages / Warning- and Alarm list for analog sensors

Alarms	Description
Watchdog time-out*	SW/System fault
Cond Cell open*	Cell running dry (no measurement solution) or wires are broken
Cond Cell shorted*	Short circuit caused by sensor or cable

* According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm)

14.3 Cond (resistive) Error messages / Warning- and Alarm list for ISM sensors

Alarms	Description
Watchdog time-out*	SW/System fault
Dry Cond sensor*	Cell running dry (no measurement solution)
Cell deviation*	Multiplier out of tolerance** (depends on sensor model).

* According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm)

** For further information refer to the sensor documentation

14.4 Cond (inductive) Error messages/ Warning- and Alarm list

Alarms	Description
Watchdog time-out*	SW/System fault
Send side open*	Wires for sending coil are broken or sensor defect
Send side short circ.*	Short circuit caused by sensor or cable for the sending coil
Receive side open*	Wires for receiving coil are broken or sensor defect

* According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm)

14.5 pH Error messages/Warning- and Alarm list

Warnings	Description
Warning pH slope >102%	Slope too big
Warning pH Slope <90%	Slope too small
Warning pH Zero >7.5 pH	Zero offset too big
Warning pH Zero <6.5 pH	Zero offset too small
Warning pHGls change <0.3	Glass electrode resistance changed by more than factor 0.3
Warning pHGls change >3	Glass electrode resistance changed by more than factor 3
Warning pHRef change <0.3	Reference electrode resistance changed by more than factor 0.3
Warning pHRef change >3	Reference electrode resistance changed by more than factor 3

Alarms	Description
Watchdog time-out*	SW/System fault
Error pH Slope >103%	Slope too big
Error pH Slope <80%	Slope too small
Error pH Zero >8.0 pH	Zero offset too big
Error pH Zero <6.0 pH	Zero offset too small
Error pH Ref Res >150 KΩ*	Reference electrode resistance too big (break)
Error pH Ref Res <2000 Ω*	Reference electrode resistance too small (short)
Error pH Gls Res >2000 MΩ*	Glass electrode resistance too big (break)
Error pH Gls Res <5 MΩ*	Glass electrode resistance too small (short)

* According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm)

14.6 Amperometric O_2 Error messages/ Warning- and Alarm list

Warnings	Description
Warning O_2 Slope <−90 nA	Slope too big
Warning O_2 Slope >−35 nA	Slope too small
Warning O_2 ZeroPt >0.3 nA	Zero offset too big
Warning O_2 ZeroPt <−0.3 nA	Zero offset too small

Alarms	Description
Watchdog time-out*	SW/System fault
Error Install O_2 Jumper	In case of using InPro 6900 a jumper has to be installed (see chapter: Connection of Sensor – Dissolved Oxygen)
Error O_2 Slope <−110 nA	Slope too big
Error O_2 Slope >−30 nA	Slope too small
Error O_2 ZeroPt >0.6 nA	Zero offset too big
Error O_2 ZeroPt <−0.6 nA	Zero offset too small

14.7 Optical O_2 Error messages/Warning- and Alarm list

Warnings	Description
Chx Cal Required*	ATC = 0 or measured values out of range
Chx CIP Counter Expired	Limit of CIP cycles reached
Chx SIP Counter Expired	Limit of SIP cycles reached
Chx Autocl. Count. Exp.	Limit of autoclaving cycles reached

* If this warning is displayed, you will find more information about the cause for the warning in Menu/Service/Diagnostics/O_2 optical

Alarms	Description
Watchdog time-out*	SW/System fault
Chx Change Spot**	Replace OptoCap
Chx Signal error**	Signal or value for temperature out of range
Chx Shaft error**	Temperature bad or stray light too high (e.g. because a glass is fiber broken) or shaft has been removed
Chx Hardware error**	Electronic components fail

** According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm)

If an alarm has occurred, you will find more information about the cause for the alarm in Menu/Service/Diagnostics/O_2 optical

14.8 ISFET Error messages/Warning- and Alarm list

Warnings	Description
Warning pH slope >102%	Slope too big
Warning pH Slope <90%	Slope too small
Warning pH Zero >7.5 pH	Zero offset too big
Warning pH Zero <6.5 pH	Zero offset too small

Alarms	Description
Watchdog time-out*	SW/System fault
Error pH Slope >103%	Slope too big
Error pH Slope <80%	Slope too small
Error pH Zero >8.0 pH	Zero offset too big
Error pH Zero <6.0 pH	Zero offset too small

* According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm).

14.9 Dissolved carbon dioxide Error messages/ Warning- and Alarm list

Warnings	Description
Warning pH slope >102%	Slope too big
Warning pH Slope <90%	Slope too small
Warning pH Zero >7.5 pH	Zero offset too big
Warning pH Zero <6.5 pH	Zero offset too small
Warning pHGls change <0.3	Glass electrode resistance changed by more than factor 0.3
Warning pHGls change >3	Glass electrode resistance changed by more than factor 3

Alarms	Description
Watchdog time-out*	SW/System fault
Error pH Slope >103%	Slope too big
Error pH Slope <80%	Slope too small
Error pH Zero >8.0 pH	Zero offset too big
Error pH Zero <6.0 pH	Zero offset too small
Error pH Gls Res >2000 MΩ*	Glass electrode resistance too big (break)
Error pH Gls Res <5 MΩ*	Glass electrode resistance too small (short)

* According to the parameterization of the transmitter (see chapter 8.5.1 "Alarm"; PATH: Menu/Configure/Alarm/Clean/Setup Alarm).

14.10 Warning- and Alarm indication on the display

14.10.1 Warning indication

If there are conditions, which generate a warning, the message will be recorded and can be selected through the menu Messages (PATH: Info / Messages; see also chapter 12.1 "Messages"). According to the parameterisation of the transmitter the hint "Failure – Press ENTER" will be shown at line 4 of the display, if a warning or alarm has occurred (see also chapter 8.7 "Display"; PATH: Menu/Configure/Display/Measurement).

14.10.2 Alarm indication

Alarms will be shown in the display by a flashing symbol ⚠ and recorded through the menu point Messages (PATH: Info/Messages; see also chapter 12.1 "Messages").

Furthermore the detection of some alarms can be activated or deactivated (see chapter 8.5 "Alarm/Clean"; PATH: Menu/Configure/Alarm/Clean) for an indication on the display. If one of these alarms occurs and the detection has been activated, the flashing symbol ⚠ will be shown on the display and the message will be recorded through the menu Messages (see chapter 12.1 "Messages"; PATH: Info / Messages).

Alarms which are caused by a violation of the limitation of a setpoint or the range (see chapter 8.4 "Setpoints"; PATH: Menu/Configure/Setpoint) will also be shown by a flashing symbol ⚠ and recorded through the menu Messages (PATH: Info/Messages; see also chapter 12.1 "Messages").

According to the parameterisation of the transmitter the hint "Failure – Press ENTER" will be shown at line 4 of the display, if a warning or alarm has occurred (see also chapter 8.7 "Display"; PATH: Menu/Configure/Display/Measurement).

15 Accessories and Spare Parts

Please contact your local Mettler-Toledo sales office or representative for details for additional accessories and spare parts.

Description	Order no.
Pipe Mount Kit for 1/2DIN models	52 500 212
Panel Mount Kit for 1/2DIN models	52 500 213
Protective Hood for 1/2DIN models	52 500 214
Terminal blocks for M300, M400	52 500 504

16 Specifications

16.1 General specifications

Conductivity/resistive Specifications	
Range 0.01 cm^{-1} constant sensor	0.002 to 200 µS/cm (5000 Ω x cm to 500 MΩ x cm)
Range 0.1 cm^{-1} constant sensor	0.02 to 2000 µS/cm (500 Ω x cm to 50 MΩ x cm)
Range 10 cm^{-1} constant sensor	10 to 40,000 µS/cm (25 Ω x cm to 100 KΩ x cm)
Display range for 2-e sensor	0 to 40,000 mS/cm (25 Ω x cm to 100 MΩ x cm)
Display range for 4-e sensor	0.01 to 650 mS/cm (1.54 Ω x cm to 0.1 MΩ x cm)
Chemical concentration curves	NaCl: 0–26% @ 0 °C to 0–28% @ +100 °C NaOH: 0–12% @ 0 °C to 0–16% @ +40 °C to 0–6% @ +100 °C HCl: 0–18% @ –20 °C to 0–18% @ 0 °C to 0–5% @ +50 °C HNO3: 0–30% @ –20 °C to 0–30% @ 0 °C to 0–8% @ +50 °C H2SO4: 0–26% @ –12 °C to 0–26% @ +5 °C to 0–9% @ +100 °C H3PO4: 0–35% @ +5 °C to +80 °C
TDS ranges	NaCl, CaCO3
Sensor maximum distance	analog: 61 m (200 ft); 15 m (50 ft with 4-E sensors) ISM: 80 m (260 ft)
Cond/Res accuracy**	±0.5% of reading or 0.25 Ω, whichever is greater, Up to 10 MΩ-cm
Cond/Res repeatability**	±0.25% of reading or 0.25 ohm, whichever is greater
Cond/Res resolution	auto/0.001/0.01/0.1/1 (can be selected)
Temperature input*	Pt1000/Pt100/NTC22K
Temperature measuring range	–40 to +200.0 °C (–40 to 392 °F)
Temperature resolution	auto/0.001/0.01/0.1/1 K (°F), (can be selected)
Temperature accuracy**	±0.25 K (±0.45 °F) within –30 to +150 °C ±0.50 K (±0.90 °F) outside
Temperature repeatability**	±0.13 K (±0.23 °F)

* Not required on ISM sensors

** For analog input signal (ISM input signal causes no additional error).

Conductivity/inductive Specifications	
Conductivity range	0 to 2000 mS/cm
Chemical concentration curves	NaCl: 0–26% @ 0 °C to 0–28% @ +100 °C NaOH-1: 0–13% @ 0 °C to 0–24 @ +100 °C NaOH-2: 15–50% @ 0 °C to 35–50 @ +100 °C HCl-1: 0–18% @ –20 °C to +50 °C HCl-2: 22–39% @ –20 °C to +50 °C HNO3-1: 0–30% @ –20 °C to +50 °C HNO3-1: 35–96% @ –20 °C to +50 °C H2SO4-1: 0–26% @ –12 °C to 0–37% @ +100 °C H2SO4-2: 28–88% @ 0 °C to 39–88% @ +95 °C H2SO4-3: 94–99% @ –12 °C to 89–99% @ +95 °C H3PO4: 0–35% @ +5 °C to +80 °C
TDS ranges	NaCl, CaCO3
Sensor maximum distance	10 m
Cond / Ind accuracy	±1% of reading ±0.005 mS/cm
Cond / Ind repeatability	±1% of reading ±0.005 mS/cm
Cond / Ind resolution	auto/0.01/0.01/0.1 (can be selected)
Temperature input	Pt1000/Pt100/NTC22K
Temperature measuring range	–40 to + 200.0 °C (–40 to 392 °F)
Temperature resolution	auto/0.001/0.01/0.1/1 K (°F), (can be selected)
Temperature accuracy	±0.25 K (±0.45 °F) within –30 to +150 °C ±0.50 K (±0.90 °F) outside
Temperature repeatability	±0.13 K (±0.23 °F)
pH incl. ISFET Specifications	
pH range	–1.00 to 15.00 pH
Sensor maximum distance	Analogue: 10 to 20 m (33 to 65 ft) depending on sensor ISM: 80 m (260 ft)
pH resolution	auto/0.01/0.1/1 (can be selected)
pH accuracy**	±0.02 pH
mV range	–1500 to 1500 mV
mV resolution	auto/0.01/0.1/1 mV
mV accuracy	±1 mV
Temperature input*	Pt1000/Pt100/NTC22K
Temperature measuring range	–30 to 130 °C (–22 to 266 °F)
Temperature resolution	auto/0.001/0.01/0.1/1 K (°F), (can be selected)
Temperature accuracy**	±0.25 K
Temperature repeatability**	±0.13 K (±0.23 °F)

* Not requried on ISM sensors

** For analog input signal (ISM input signal causes no additional error).

Available Buffer Sets:	
MT-9 buffers, MT-10 buffers, NIST Technical Buffers, NIST Standard Buffers (DIN 19266:2000–01), JIS Standard, Hach buffers, CIBA (94) buffers, Merck Titrisols-Reidel Fixanals, WTW buffers	
Oxygen Specifications	
Measuring range current	0 to 900 nA
Sensor maximum distance	Analogue: 20 m (65 ft) ISM: 80 m (260 ft)
Concentration range	0.1 ppb (µg/l) to 50.00ppm (mg/l)
DO accuracy**	Saturation: 0.5% of reading or 0.5% (whichever is greater) Concentration: Oxygen high: 0.5% of reading or 0.050ppm resp. 0.050mg/l (whichever is greater) Oxygen low: 0.5% of reading or 0.001ppm resp. 0.001mg/l (whichever is greater)
O2 gas accuracy**	0.5% of reading or 5ppb O2 gas (whichever is greater) for ppm resp. ppb O2 gas 0.5% of reading or 0.01% (whichever is greater) for Vol% O2 gas
Resolution	auto/0.001/0.01/0.1/1, (can be selected)
Temperature input*	Pt1000/NTC22K
Temperature measuring range	–30 to 150 °C (–22 to 302 °F)
Temperature resolution	auto/0.001/0.01/0.1/1 K (°F), (can be selected)
Temperature accuracy**	±0.25 K within –10 to +80 °C
Temperature repeatability**	±0.13 K (±0.23 °F)

* Not requried on ISM sensors

** For analog input signal (ISM input signal causes no additional error).

Dissolved Carbon Dioxide Specifications	
CO_2 measuring ranges	0 … 5000 mg/l 0 … 200%sat 0 … 1500 mmHg 0 ... 2000 mbar 0 ... 2000 hPa
Sensor maximum distance	15 m (49 ft)
CO_2 accuracy	±5% of reading ±2 mg/l, resp. ±0.2% of reading ±2 hPa
CO_2 resolution	auto/0.001/0.01/0.1/1, (can be selected)
mV range	−1500 to 1500 mV
mV resolution	auto/0.01/0.1/1 mV
mV accuracy	±1 mV
Total pressure range (TotPres)	0 … 4000 mbar
Temperature input	Pt1000/NTC22K
Temperature measuring range	−30 to 150 °C (−22 to 302 °F)
Temperature resolution	auto/0.001/0.01/0.1/1 K (°F), (can be selected)
Temperature accuracy	−40 to + 200.0 °C (−40 to 392 °F)
Temperature repeatability	auto/0.001/0.01/0.1/1 K (°F), (can be selected)
Temperature accuracy	±0.25 K within −10 to +80 °C
Temperature repeatability	±0.13 K (±0.23 °F)
Available Buffer Set:	
MT-9 buffers with solution pH = 7.00 and pH = 9.21 @ 25 °C	

16.2 Electrical specifications

Power requirements	100 to 240 V AC or 20 to 30 V DC, 10 VA, AWG 14 <2.5 mm^2
Frequency	50 to 60 Hz
Analog output signals	Four 0/4 to 20 mA outputs, galvanically isolated from input and from earth/ground
Measurement Error through analog outputs	<±0.05 mA over 1 to 22 mA range, <±0.1 mA over 0 to 1 mA range
Analog output configuration	Linear, Bi-Linear, Logarithmic, Autoranging
Load	max. 500 Ω
Connection terminals	Detachable screw terminals
Digital communication	USB port, Type B connector
PID process controller	Pulse length, pulse frequency or analog control
Cycle time	Ca. 1 second
Connection terminals	Detachable screw terminals
Digital Input	2 with swtiching limits 0.00 VDC to 1.00 VDC for low level and 2.30 VDC to 30.00 VDC for high level
Mains power fuse	1.0 A slow blow type FC
Relays	2-SPDT mechanical 250 VAC, 30 VDC,3 Amps 2-SPST mechanical rated at 250 VAC, 3 Amps 2-Reed 250 VAC or DC, 0.5 A
Alarm Relay delay	0–999 s
Keypad	5 tactile feedback keys
Display	four-line
Max. cable length ISM	80 m

NOTE: This is a 4-wire-product with an active 4–20 mA analog output.
Please do not supply to Pin1–Pin6 of TB2.

16.3 Mechanical specifications

Dimensions (housing – H x W x D)*	144 x 144 x 116 mm
Front bezel – H x W	150 x 150 mm
Max. D – panel mounted	87 mm (excludes plug-in connectors)
Weight	0.95 kg (2 lb)
Material	ABS/polycarbonate
Ingress rating	IP 65 (when back cover is attached)

* H = Height, W = Width, D = Depth

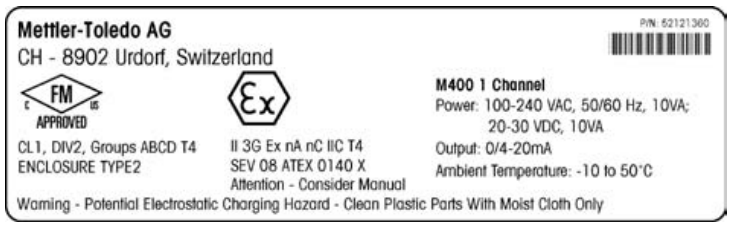
16.4 Environmental specifications

Storage temperature	–40 to 70 °C (–40 to 158 °F)
Ambient temperature operating range	–10 to 50 °C (14 to 122 °F)
Relative humidity	0 to 95% non-condensing
Emissions	According to EN55011 Class A
Hazardous areas	Type 1, Type 2, Type 3: cFMus Class I Division 2, ATEX Zone 2 Type 1 Cond Ind: cFMus Class I Division 2 (in preparation) ATEX Zone 2 (in preparation)
Ratings / Approvals	CE Compliant

16.5 Ex Classification

NOTE: The Ex classification is valid for the transmitters M400 Type 1, M400 Type 2 and M400 Type 3. For the transmitter M400 Type 1 Cond Ind the approvals are in preparation.

Type plate



Rating

Supply current circuit N(–) and L(+) –	100–240 V AC, 50/60 Hz, 10 W 20–30 V DC, 10 W
Relay current circuits (connections, TB1)	up to 250 V AC max. 20 W or up to 30 V DC max. 20 W
analogue outputs (connections, TB2)	$U_{max.}$ = 15 V, $I_{max.}$ = 255 mA, $P_{max.}$ = 2.5 W
analogue sensor pH, O_2, LF (connections, TB3, terminal 1–8)	$U_{max.}$ = 5.3 V, $I_{max.}$ ≤ 5 mA, $P_{max.}$ ≤ 26.5 mW
digital sensor pH, O_2 (connections, TB4, terminal 3–4)	$U_{max.}$ ≤ 5.3 V, $I_{max.}$ ≤ 18 mA, $P_{max.}$ ≤ 24 mW

17 Default table

Parameter	Sub parameter	Value	Unit
Alarm	Relay	2	
	Power Failure	No	
	Software Failure	No	
	ChB Disconnected	No	
	Rg diagnostics	No	
	Rr diagnostics	No	
	Cond Cell open	No	
	Cond cell shorted	No	
	Shaft error	No	
	Signal error	No	
	Hardware error	No	
	Cond Ind defect	No	
	Dry Cond sensor	No	
	Cell deviation	No	
	Lifetime indicator	No	
	Time To Maintenance	No	
	Adaptive Cal Timer	No	
	CIP cycle counter	No	
	SIP cycle counter	No	
	Autoclave cycle counter	No	
	Hold Mode*	Last	
	Delay	1	Sec
	Hysteresis	0	
	State	Inverted	
Clean	Relay	1	
	Interval	0	Hrs
	Clean Time	0	Sec
	State	Normal	
	Delay	0	
	Hysteresis	0	
Language		English	
Passwords	Administrator	00000	
	Operator	00000	
All Relays (unless otherwise specified)	Delay	10	Sec
	Hysteresis	5	%
	State	Normal	
	Hold mode	Last	
Lockout	Yes/No	No (= off)	
Channel A	Measurement a	pH (M400, Type 1,2,3)	
		Conductivity (M400, Type 1 Cond Ind)	mS/cm
	Measurement b	Temperature	°C
Channel B	Measurement c	Auto	
	Measurement d	Auto	

* For analogue output signal if relay is switched

Parameter	Sub parameter	Value	Unit
Cal constants (analog sensors)	Cond/Res	M = 0.1, A = 0.0	cm^{-1} Ω
	Cond/Ind	M = 2.1750, A = 0.0	cm^{-1} Ω
	O2 high	S = –70.00 A = 0.0	nA nA
	O2 low	S = –350.00 A = 0.0	nA nA
	pH incl. ISFET	S = 100.0, Z = 7.0	% pH
	pH – mV	S = 1.0, Z = 0.0	
	CO_2	S = 100.0 Z = 7.0	% pH
	Temperature	M = 1.0, A = 0.0	Ω
Analog Out	1	Ch A – pH (M400 Type 1, 2, 3)	MΩ-cm
		Ch A – Conductivity (M400 Type 1 Cond Ind)	S/cm
	2	Ch A – Temperature	°C
	3	Ch B – pH (M400 Type 1, 2, 3)	MΩ-cm
		Ch B – Conductivity (M400 Type 1 Cond Ind)	S/cm
	4	Ch B – Temperature	°C
All analog out	Mode	4 – 20 mA	
	Type	Normal	
	Alarm	Off	
	Hold mode	Last value	
Conductivity *Resitivity*	Value 4 mA	0.1 *10*	µS/cm *MΩ-cm*
	Value 20 mA	10 *20*	µS/cm *MΩ-cm*
Dissolved Oxygen (M400, type 2)	Value 4 mA	0	%sat
	Value 20 mA	100	%sat
Dissolved Oxygen (M400, type 3)	Value 4 mA	0.000	ppb
	Value 20 mA	100.0	ppb
pH incl. ISFET	Value 4 mA	2.000	pH
	Value 20 mA	12.00	pH
Dissolved carbon dioxide	Value 4 mA	0	hPa
	Value 20 mA	100	hPa
Temperature	Value 4 mA	0	°C
	Value 20 mA	100	°C
Set point 1	Measurement	a	
	Type	Off	
Conductivity *Resistivity*	High Value	0 *0*	S/cm *MΩ-cm*
	Low Value	0 *0*	S/cm *MΩ-cm*
O2	High Value	50	% sat
	Low Value	0	% sat
pH (incl. ISFET)	High Value	12	pH
	Low Value	0	pH

Parameter	Sub parameter	Value	Unit
Relay 3	Set Point	1	
Set point 2	Measurement	c	
	Type	Off	
Conductivity *Resistivity*	High Value	0 *0*	S/cm *MΩ-cm*
	Low Value	0 *0*	S/cm *MΩ-cm*
O2	High Value	50	% sat
	Low Value	0	% sat
pH (incl. ISFET)	High Value	12	pH
	Low Value	0	pH
Relay 4	Set Point	2	
Resolution		Auto	
Set Point3	Measurement	_(none)	
	Type	Off	
	Relay	_(none)	
Set Point4	Measurement	_(none)	
	Type	Off	
	Relay	_(none)	
Conductivity *Resistivity*	Compensation	Standard	
Amperometric O_2	Umeaspol	−675	mV
	Ucalpol	−675	mV
	CalPres	759.8	mmHg
	ProcPres	759.8	mmHg
	ProcCalPres	CalPres	
	Salinity	0.0	g/kg
	Humidity	100	%
Optical O_2	CalPres	759.8	mmHg
	ProcPres	759.8	mmHg
	ProcCalPres	CalPres	
	Salinity	0.0	g/kg
	Humidity	100	%
	Sampling rate	1	sec/ measurement
	LED Mode	Auto	
pH	Drift Control	Auto	
	IP	7.0	pH
	STC	0.000	pH/°C
	FixCalTemp	No	
	pH Buffer	Mettler-9	
	Cal info slope	[%]	
	Cal info offset	[pH]	

18 Warranty

METTLER TOLEDO warrants this product to be free from significant deviations in material and workmanship for a period of one year from the date of purchase. If repair is necessary and not the result of abuse or misuse within the warranty period, please return by freight pre-paid and amendment will be made without any charge. METTLER TOLEDO's Customer Service Dept. will determine if the product problem is due to deviations or customer abuse. Out-of-warranty products will be repaired on an exchange basis at cost.

The above warranty is the only warranty made by METTLER TOLEDO and is lieu of all other warranties, expressed or implied, including, without limitation, implied warranties of merchantability and fitness for a particular purpose. METTLER TOLEDO shall not be liable for any loss, claim, expense or damage caused by, contributed to or arising out of the acts or omissions of the Buyer or Third Parties, whether negligent or otherwise. In no event shall METTLER TOLEDO's liability for any cause of action whatsoever exceed the cost of the item giving rise to the claim, whether based in contract, warranty, indemnity, or tort (including negligence).

19 Buffer tables

M400 transmitters have the ability to do automatic pH buffer recognition. The following tables show different standard buffers that are automatically recognized.

19.1 Mettler-9

Temp (°C)	**pH of buffer solutions**			
0	2.03	4.01	7.12	9.52
5	2.02	4.01	7.09	9.45
10	2.01	4.00	7.06	9.38
15	2.00	4.00	7.04	9.32
20	2.00	4.00	7.02	9.26
25	2.00	4.01	7.00	9.21
30	1.99	4.01	6.99	9.16
35	1.99	4.02	6.98	9.11
40	1.98	4.03	6.97	9.06
45	1.98	4.04	6.97	9.03
50	1.98	4.06	6.97	8.99
55	1.98	4.08	6.98	8.96
60	1.98	4.10	6.98	8.93
65	1.99	4.13	6.99	8.90
70	1.99	4.16	7.00	8.88
75	2.00	4.19	7.02	8.85
80	2.00	4.22	7.04	8.83
85	2.00	4.26	7.06	8.81
90	2.00	4.30	7.09	8.79
95	2.00	4.35	7.12	8.77

19.2 Mettler-10

Temp (°C)	**pH of buffer solutions**			
0	2.03	4.01	7.12	10.32
5	2.02	4.01	7.09	10.25
10	2.01	4.00	7.06	10.18
15	2.00	4.00	7.04	10.12
20	2.00	4.00	7.02	10.06
25	2.00	4.01	7.00	10.01
30	1.99	4.01	6.99	9.97
35	1.99	4.02	6.98	9.93
40	1.98	4.03	6.97	9.89
45	1.98	4.04	6.97	9.86
50	1.98	4.06	6.97	9.83
55	1.98	4.08	6.98	9.83
60	1.98	4.10	6.98	9.83
65	1.99	4.13	6.99	9.83
70	1.99	4.16	7.00	9.83
75	2.00	4.19	7.02	9.83
80	2.00	4.22	7.04	9.83
85	2.00	4.26	7.06	9.83
90	2.00	4.30	7.09	9.83
95	2.00	4.35	7.12	9.83

19.3 NIST Technical Buffers

Temp (°C)	**pH of buffer solutions**				
0	1.67	4.00	7.115	10.32	13.42
5	1.67	4.00	7.085	10.25	13.21
10	1.67	4.00	7.06	10.18	13.01
15	1.67	4.00	7.04	10.12	12.80
20	1.675	4.00	7.015	10.06	12.64
25	1.68	4.005	7.00	10.01	12.46
30	1.68	4.015	6.985	9.97	12.30
35	1.69	4.025	6.98	9.93	12.13
40	1.69	4.03	6.975	9.89	11.99
45	1.70	4.045	6.975	9.86	11.84
50	1.705	4.06	6.97	9.83	11.71
55	1.715	4.075	6.97	9.83*	11.57
60	1.72	4.085	6.97	9.83*	11.45
65	1.73	4.10	6.98	9.83*	11.45*
70	1.74	4.13	6.99	9.83*	11.45*
75	1.75	4.14	7.01	9.83*	11.45*
80	1.765	4.16	7.03	9.83*	11.45*
85	1.78	4.18	7.05	9.83*	11.45*
90	1.79	4.21	7.08	9.83*	11.45*
95	1.805	4.23	7.11	9.83*	11.45*

* Extrapolated

19.4 NIST standard buffers (DIN and JIS 19266: 2000–01)

Temp (°C)	**pH of buffer solutions**			
0				
5	1.668	4.004	6.950	9.392
10	1.670	4.001	6.922	9.331
15	1.672	4.001	6.900	9.277
20	1.676	4.003	6.880	9.228
25	1.680	4.008	6.865	9.184
30	1.685	4.015	6.853	9.144
35	1.694	4.028	6.841	9.095
40	1.697	4.036	6.837	9.076
45	1.704	4.049	6.834	9.046
50	1.712	4.064	6.833	9.018
55	1.715	4.075	6.834	8.985
60	1.723	4.091	6.836	8.962
70	1.743	4.126	6.845	8.921
80	1.766	4.164	6.859	8.885
90	1.792	4.205	6.877	8.850
95	1.806	4.227	6.886	8.833

NOTE: The pH(S) values of the individual charges of the secondary reference materials are documented in a certificate of an accredited laboratory. This certificate is supplied with the respective buffer materials. Only these pH(S) values shall be used as standard values for the secondary reference buffer materials. Correspondingly, this standard does not include a table with standard pH values for practical use. The table above only provides examples of pH(PS) values for orientation.

19.5 Hach buffers

Buffer values up to 60 °C as specified by Bergmann & Beving Process AB.

Temp (°C)	**pH of buffer solutions**		
0	4.00	7.14	10.30
5	4.00	7.10	10.23
10	4.00	7.04	10.11
15	4.00	7.04	10.11
20	4.00	7.02	10.05
25	4.01	7.00	10.00
30	4.01	6.99	9.96
35	4.02	6.98	9.92
40	4.03	6.98	9.88
45	4.05	6.98	9.85
50	4.06	6.98	9.82
55	4.07	6.98	9.79
60	4.09	6.99	9.76
65	4.09*	6.99*	9.76*
70	4.09*	6.99*	9.76*
75	4.09*	6.99*	9.76*
80	4.09*	6.99*	9.76*
85	4.09*	6.99*	9.76*
90	4.09*	6.99*	9.76*
95	4.09*	6.99*	9.76*

* Values complemented

19.6 Ciba (94) buffers

Temp (°C)	**pH of buffer solutions**			
0	2.04	4.00	7.10	10.30
5	2.09	4.02	7.08	10.21
10	2.07	4.00	7.05	10.14
15	2.08	4.00	7.02	10.06
20	2.09	4.01	6.98	9.99
25	2.08	4.02	6.98	9.95
30	2.06	4.00	6.96	9.89
35	2.06	4.01	6.95	9.85
40	2.07	4.02	6.94	9.81
45	2.06	4.03	6.93	9.77
50	2.06	4.04	6.93	9.73
55	2.05	4.05	6.91	9.68
60	2.08	4.10	6.93	9.66
65	2.07*	4.10*	6.92*	9.61*
70	2.07	4.11	6.92	9.57
75	2.04*	4.13*	6.92*	9.54*
80	2.02	4.15	6.93	9.52
85	2.03*	4.17*	6.95*	9.47*
90	2.04	4.20	6.97	9.43
95	2.05*	4.22*	6.99*	9.38*

* Extrapolated

19.7 Merck Titrisole, Riedel-de-Haën Fixanale

Temp (°C)	**pH of buffer solutions**				
0	2.01	4.05	7.13	9.24	12.58
5	2.01	4.05	7.07	9.16	12.41
10	2.01	4.02	7.05	9.11	12.26
15	2.00	4.01	7.02	9.05	12.10
20	2.00	4.00	7.00	9.00	12.00
25	2.00	4.01	6.98	8.95	11.88
30	2.00	4.01	6.98	8.91	11.72
35	2.00	4.01	6.96	8.88	11.67
40	2.00	4.01	6.95	8.85	11.54
45	2.00	4.01	6.95	8.82	11.44
50	2.00	4.00	6.95	8.79	11.33
55	2.00	4.00	6.95	8.76	11.19
60	2.00	4.00	6.96	8.73	11.04
65	2.00	4.00	6.96	8.72	10.97
70	2.01	4.00	6.96	8.70	10.90
75	2.01	4.00	6.96	8.68	10.80
80	2.01	4.00	6.97	8.66	10.70
85	2.01	4.00	6.98	8.65	10.59
90	2.01	4.00	7.00	8.64	10.48
95	2.01	4.00	7.02	8.64	10.37

19.8 WTW buffers

Temp (°C)	**pH of buffer solutions**			
0	2.03	4.01	7.12	10.65
5	2.02	4.01	7.09	10.52
10	2.01	4.00	7.06	10.39
15	2.00	4.00	7.04	10.26
20	2.00	4.00	7.02	10.13
25	2.00	4.01	7.00	10.00
30	1.99	4.01	6.99	9.87
35	1.99	4.02	6.98	9.74
40	1.98	4.03	6.97	9.61
45	1.98	4.04	6.97	9.48
50	1.98	4.06	6.97	9.35
55	1.98	4.08	6.98	
60	1.98	4.10	6.98	
65	1.99	4.13	6.99	
70	2.00	4.16	7.00	
75	2.00	4.19	7.02	
80	2.00	4.22	7.04	
85	2.00	4.26	7.06	
90	2.00	4.30	7.09	
95	2.00	4.35	7.12	

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